REPORT OF SURVEY CONDUCTED AT

CRANE ARMY AMMUNITION ACTIVITY
CRANE, IN

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Best Manufacturing Practices

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Foreword

This report was produced by the Best Manufacturing Practices (BMP) Program, a unique industry and government cooperative technology transfer effort that improves the competitiveness of America's industrial base both here and abroad. Our main goal at BMP is to increase the quality, reliability, and maintainability of goods produced by American firms. The primary objective toward this goal is simple: to identify best practices, document them, and then encourage industry and government to share information about them.

The BMP Program set out in 1985 to help businesses by identifying, researching, and promoting exceptional manufacturing practices, methods, and procedures in design, test, production, facilities, logistics, and management – all areas which are highlighted in the Department of Defense's 4245-7.M, *Transition from Development to Production* manual. By fostering the sharing of information across industry lines, BMP has become a resource in helping companies identify their weak areas and examine how other companies have improved similar situations. This sharing of ideas allows companies to learn from others' attempts and to avoid costly and time-consuming duplication.

BMP identifies and documents best practices by conducting in-depth, voluntary surveys such as this one at Crane Army Ammunition Activity conducted during the week of February 28, 2000. Teams of BMP experts work hand-in-hand on-site with the activity to examine existing practices, uncover best practices, and identify areas for even better practices.

The final survey report, which details the findings, is distributed electronically and in hard copy to thousands of representatives from government, industry, and academia throughout the U.S. and Canada – *so the knowledge can be shared.* BMP also distributes this information through several interactive services which include CD-ROMs, BMPnet, and a World Wide Web Home Page located on the Internet at http://www.bmpcoe.org. The actual exchange of detailed data is between companies at their discretion.

Crane Army Ammunition Activity is an installation within the U.S. Army Industrial Operations Command, a major subordinate command of the U.S. Army Materiel Command. The Activity's mission is to produce and renovate conventional ammunition and ammunition-related components; perform manufacturing, engineering, and product assurance in support of production; and store, ship, and/or demilitarize and dispose of conventional ammunition and related items. Among the best examples were Crane Army Ammunition Activity's One-Stop Machine Shop, White Phosphorus Conversion, Energy Savings Performance Contracts, and Flexible Workforce

The Best Manufacturing Practices Program is committed to strengthening the U.S. industrial base. Survey findings in reports such as this one on Crane Army Ammunition Activity expand BMP's contribution toward its goal of a stronger, more competitive, globally-minded, and environmentally-conscious America.

I encourage your participation and use of this unique resource.

Anne Marie T. SuPrise, Ph.D.
Acting Director, Best Manufacturing Practices

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Section 1

Report Summary

Background

Crane Army Ammunition Activity is an installation within the U.S. Army Industrial Operations Command, a major subordinate command of the U.S. Army Materiel Command. The Activity is one of three government owned/government operated ammunition production facilities within the Department of Defense and was activated on October 1, 1977 in response to Department of Defense's implementation of the Single Manager for Conventional Ammunition concept, which gave the Army the task of providing conventional ammunition/production/storage services to all branches of the military. The Activity's mission is to produce and renovate conventional ammunition and ammunition-related components; perform manufacturing, engineering, and product assurance in support of production; and store, ship, and/or demilitarize and dispose of conventional ammunition and related items.

Crane Army Ammunition Activity, a tenant activity at Crane Division, Naval Surface Warfare Center, is located on a 62,473-acre (a 100-square mile) site approximately thirty miles south of Bloomington, Indiana. This vast area includes 209 administrative and production buildings, 177 warehouses to store inert material, and 1,600 explosive magazines. The local infrastructure includes 168 miles of rail and 407 miles of road. The production, handling, and storage of munitions require specialized equipment and related facilities. The Activity maintains the only operational white phosphorous demilitarization conversion plant in North America. The technology contained in this plant allows the Activity to extract deadly white phosphorous from old munitions and convert it into relatively harmless phosphoric acid that may ultimately be used in carbonated beverages and fertilizer. X-ray equipment is used in the nondestructive, real time testing of items such as 40mm mortar rounds to ensure quality products to the warfighter. A variety of special lifting devices allows workers to easily handle objects as large as 1,000-pound bombs.

The Activity's manufacturing capabilities include the ability to produce finished items as diverse as detonators weighing only 20 grams to 40,000-pound cast shock test charges. The Activity has extensive renovation and maintenance capabilities for conventional munitions, and is the recognized center of technical expertise in the production of pyrotechnic devices including signal smoke, illuminating and infrared flares, and distress signals. The Activity is one of four Tier 1 Ammunition Storage Sites within the Department of Defense which stores war reserve ammunition to meet initial ammunition needs in the first 30 days of a conflict.

Crane Army Ammunition Activity's organizational structure includes four major directorates, one center, and five staff offices, which directly support the organization. For many years, quality at the Activity was achieved through a formal quality assurance program. In early 1997, however, a new approach to quality was undertaken. A Total Quality Office was established with a charter to focus on quality improvements within the organization. A formal Quality Council was established to oversee the efforts to improve quality throughout the entire organization. An activity based costing study was completed in October 1997 identifying the Activity's entire core and supporting processes. Process improvement opportunities are chosen from this list of processes and pursued by process action teams chartered by the Quality Council. In July 1998, the Activity became one of only a handful of organizations within the Federal Government to be ISO-9002 certified by a third-party registrar. Efforts continue to integrate Activity Based Management within a structured ISO-9002 environment by seeking to improve the processes which define the Activity and ensure quality products to the customer. Crane Army Ammunition Activity operates in a highly competitive environment, and the decision to seek ISO-9002 certification was made in order to partner with ISO-certified civilian contractors who would prefer, or in many cases be required, to only subcontract work to ISO-9000 certified organizations. In the time since becoming certified, the Activity has already won several contracts as a result of this strategy. For example, it recently won a five-year demilitarization contract with Parsons Brinckerhoff worth more than $50 million.

Crane Army Ammunition Activity's ultimate customers are the warfighters in the U.S. Army, Navy,

Air Force, Marines, and Coast Guard who use the products. The Activity's defect rate in the area of manufacturing is closely monitored to ensure that only quality goods are shipped. The Activity's record for the delivery of munitions to the field is exceptional with a 99% on-time delivery rate. The Activity consistently strives to be the best in the business of producing and supplying ordnance material to U.S. fighting forces, and the high volume of repeat business is an important indicator of its high level of customer satisfaction.

To partner with local businesses, Crane Army Ammunition Activity and its host, Naval Surface Warfare Center, Crane Division developed the Crane Regional Economic Development Organization. The Activity's management holds two positions on the board. The purpose of this organization is for the Activity to team with local businesses on projects that will aid both public and private industry. In addition, it has joined with the Indiana Department of Commerce, area chambers of commerce, and Indiana Business Modernization and Technology Corporation, to develop and expand the state's economy.

C-4 is an explosive compound used in certain munitions. The Activity recently acquired a C-4 extruder from the Louisiana Army Ammunition Plant, which now gives it the ability to re-use C-4 from existing munitions with an estimated cost savings of more than $67 million to the U.S. Marine Corps. The Activity's surveillance test area modernization will be completed in this calendar year. This facility will be used by surveillance inspectors to test and certify munitions stored at the Activity. The Activity's container transfer process has also been enhanced with the construction of new facilities. This will increase the efficiency with which it is able to ship or receive munitions by increasing out-load capabilities from 95 containers per day to 310 containers per day — an increase of 200%.

During FY99, Crane Army Ammunition Activity established an internal record by logging approximately 670,000 work-hours without a lost workday case. During the last fiscal year, the Activity received the Army Materiel Command's Fire Prevention and Protection Award in addition to Honorable Mention for the Indiana Governor's Award for Excellence in Pollution Prevention. The can-do attitude and the employee work ethic were readily apparent to the BMP survey team. When faced with developing new tools or facilities to perform new work or improve the manufacturing processes, the Crane Army Ammunition Activity team has the ability to make the best use of all resources at its disposal. The close working relationship between the Activity and Crane Division, Naval Surface Warfare Center provides a synergistic environment that fosters the ability to take on complex tasks beyond the capabilities of each alone. The BMP survey team considers the practices in this report to be among the best in industry and government.

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Section 2

Best Practices

Production

Autoclave Bomb Meltout System

With the receipt of a contract in 1995 to perform demilitarization on 750-pound Tritonal filled bombs, Crane Army Ammunition Activity designed and developed a process that allows the explosive material to be removed through the nose of the bomb skin, eliminating the need for a separate facility to remove the base of the bomb.

The traditional approach to the demilitarization of a 750-pound Tritonal-filled bomb at Crane Army Ammunition Activity (CAAA) or any other government facility was open detonation or manual extraction by cutting off the base of the bomb and steam- or autoclave-out the explosive material. There were several drawbacks to both methods. With open detonation, neither the explosive nor the metallic container could be recovered, the emissions required extensive tracking and reporting to the proper authorities, and weather conditions determined the work schedule. The second method required the base of the bomb to be removed with a power metal bomb saw. The operator would have to set up the operation at one facility and then move to a remote facility to view the actual cutting process by video transmission. The resultant residue in the water from this cutting procedure also required purification.

CAAA did not have the facility for the treatment of the water nor a bomb saw. It is estimated that such a facility would cost $500,000. With the receipt of a contract in 1995 to perform demilitarization on 750-pound Tritonal filled bombs, CAAA designed and developed a new process that allows the explosive material to be removed through the nose of the bomb skin, eliminating the need for a separate facility to remove the base of the bomb. This is done by removing the nose fuze wall liner, and using a high-pressure waterjet nozzle to remove the tar nose pad. The bomb is then placed nose first into an autoclave explosive collection system to melt out the Tritonal explosive material under controlled heat and pressure procedures. The explosive is then pumped to a holding vacuum to bring the moisture content down to an acceptable level where it is transported to a conveyor belt for additional cooling prior to packaging for shipment. This extraction method allows the explosive and the metal bomb skin to be recycled commercially, with the option of retaining small donor quantities of Tritonal explosives for use in other open detonation applications at CAAA. Secondly, the handling of the explosive articles is reduced by 50%, and has shown a four to six times faster turnaround in the meltout operation over steam wand applications.

Since the introduction of the Autoclave Bomb Meltout System (Figure 2-1) in 1996, more than nine million pounds of Tritonal explosive and 8.75 million pounds of steel have been recovered from 24,497 bombs. This process has also been adopted by other facilities within the Army commands that perform demilitarization.

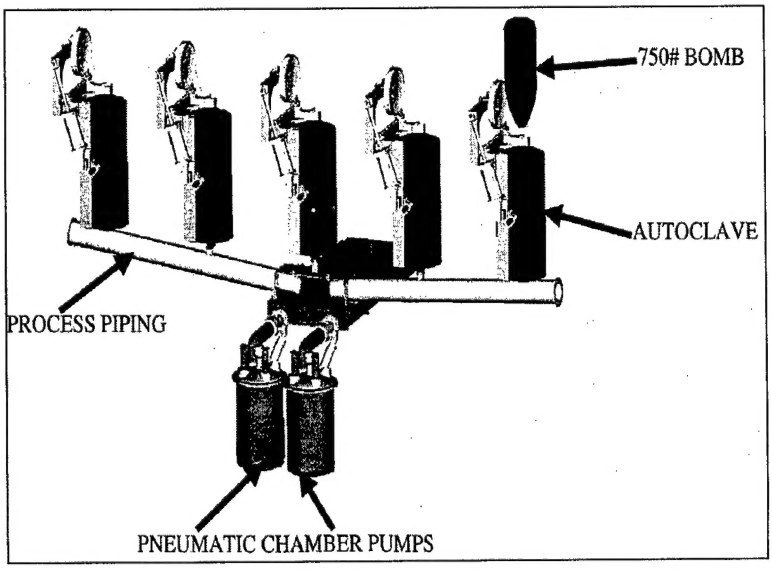

Figure 2-1. Autoclave Bomb Meltout System

Bomb Renovation Line Automation

In 1995, Crane Army Ammunition Activity implemented a process using a robot and high-pressure waterjet system to strip AVCO protection from bombs, greatly improving the safety and productivity of the operation.

Crane Army Ammunition Activity (CAAA) has developed a method of stripping AVCO protection from bombs, which greatly improved the safety and productivity of the operation. The AVCO protective coating is used for thermal protection in harsh environments. The previous method proved to be time consuming and inefficient. The new operation is automated, stripping the material in 33% of the time of the old method and produces a 100% yield of product.

During 1992 to 1993, bombs were stripped of the AVCO protective coating using manpower and pneumatic chisels and grinders. This method required two operators 30 minutes to remove as much of the AVCO protective coating as possible. The operation was strenuous and required the use of protective clothing due to asbestos in the AVCO material. If the coating could not be removed, the bomb was re-coated and, if the percentage of new material coverage was sufficient, it, was classified as shipboard qualified. A high percentage of the renovated bombs could not meet shipboard requirements.

Implemented in 1995, the current method uses a robot and a high-pressure waterjet system. The robot was installed in the front of a waterfall paint booth so any over-spray or dust coming off the bomb would be exhausted. The process is done by loading the bomb on the reutilized monorail system, conveying the bomb into the booth, and turning on the waterjet and the robot. In 14 minutes, a 500-pound bomb is stripped of all AVCO protective coating. CAAA's investment in this process change was minimal. The robot came from the Ammunition Peculiar Equipment program, the waterjet had been purchased and used on a previous program, and an old bomb conveyor and bomb inverter were used for the monorail. The only new piece of equipment that had to be fabricated was the bomb spinner, which spins the bomb as the waterjet removes the coating. This process removes all of the coating and allows for new coating to be applied, obtaining a 100% yield of shipboard-qualified bombs.

The health hazards of working with asbestos were reduced to a minimum along with ergonomic improvements to the workers' environment. The quality of the new AVCO application was greatly improved due to 100% removal of old AVCO. Reutilization of existing equipment as opposed to purchasing new equipment is a practice CAAA performs regularly, greatly reducing overhead for new workload.

C-4 Extruder Relocation

Crane Army Ammunition Activity has the capability to relocate and modernize excess automated production equipment and produce product with a quick response time to the customer's request. This competency was proven by the relocation of the C-4 Extruder line from Louisiana. The Activity is now one of two Department of Defense facilities with the capability to process C-4 explosives and assemble C-4 ammunition items.

Crane Army Ammunition Activity (CAAA) has the capability to relocate and modernize excess automated production equipment and produce product with a quick response time to the customer's request. This competency has been proven on two large projects in the past six years — with the relocation and utilization of assembly equipment that originally assembled the 155mm rounds in Mississippi, and more recently, the relocation of the C-4 Extruder line from Louisiana. Both operations provided the customer with quality product ahead of schedule with limited expense to CAAA.

When the USMC needed to renovate its 155mm round, they asked CAAA to do the work, but wanted CAAA to utilize a fully automated assembly line in Mississippi. CAAA engineers accepted the challenge due to the longevity of the program. The equipment was disassembled, moved to Crane, assembled, fitted with programmable logic controllers, modified to meet existing requirements, and put into service four days ahead of schedule. The 155mm rework program was discontinued one year later by forces beyond CAAA's control, but CAAA's ability to reutilize excess government owned equipment was proven and remembered.

The USMC returned to CAAA in April 1997 to request a similar renovation program. The program required a C-4 Extruder located in an inactive Louisiana facility. CAAA engineering accepted the

challenge and proceeded with the Extruder relocation. CAAA solicited the assistance of Army and Air Force Reserve personnel and an active duty Army Transportation Battalion to remove and transport the equipment to Crane by July 1997. At Crane, the allocation of installation funding slowed progress until January 1998. The nature of the C-4 extrusion process demands that a building to house the Extruder be more than 250 feet away from the workers who prepare and repackage the C-4 (Figure 2-2). The extruder building and conveyor tunnel were completed in April 1999. One very unique cost saving technique used was to purchase eight-foot road culverts to house the return loop conveyor. This 8' by 6' pipe tunnel was used as the conduit for electrical, fire protection, equipment control wiring, and conveyor enclosure. Estimated savings for utilizing the commercially available road culverts for the return loop conveyor was in excess of $90,000, and the culverts were buried to assist with security requirements. This relocated equipment was built in 1974. The overhead bucket feed conveyors, flat belt return conveyors, workstations, extruder, and control room were reinstalled. The extruder control system was outfitted with Allen-Bradley remote input/output, sensors, a vision system, touch screen control panel, and programmable logic control technology for less than $100,000.

CAAA is now one of two Department of Defense facilities with the capability to process C-4 explosives and assemble C-4 ammunition items. By utilizing reserve services to remove and transport the equipment to Crane, the equipment investment was 75% less than the new equipment cost, and also provided an excellent training mission for Active and Reserve personnel. All C-4 used in this extrusion process has been reclaimed from other ammunition items.

Cavity Liner Cutting Tool

In 1995, Crane Army Ammunition Activity began planning and estimating for a major demilitarization project for the M117 bomb. The Activity developed an alternate method and tool to remove the bomb base which avoided facilitation costs and simplified the material handling of bombs and explosives.

In 1995, Crane Army Ammunition Activity (CAAA) began planning and estimating for a major demilitarization project for the 750-pound M117 bomb. This would ultimately entail 24,497 bombs being decontaminated to a 3X level over a one-year period. CAAA would be acting as a subcontractor to the prime contractor, Global Environmental Solutions. The traditional demilitarization methods for 750-pound bombs at CAAA, or other government or contractor-operated facilities, were either by open detonation or cutting off the bomb base to steam or autoclave out the explosive. Open detonation did not allow for recovery of the explosives or the metal parts, and generated nitric oxide and carbon monoxide air emissions. The 750-pound bombs contained 386 pounds of Tritonal explosive(80% TNT and 20% aluminum powder) which was fully recoverable for reuse.

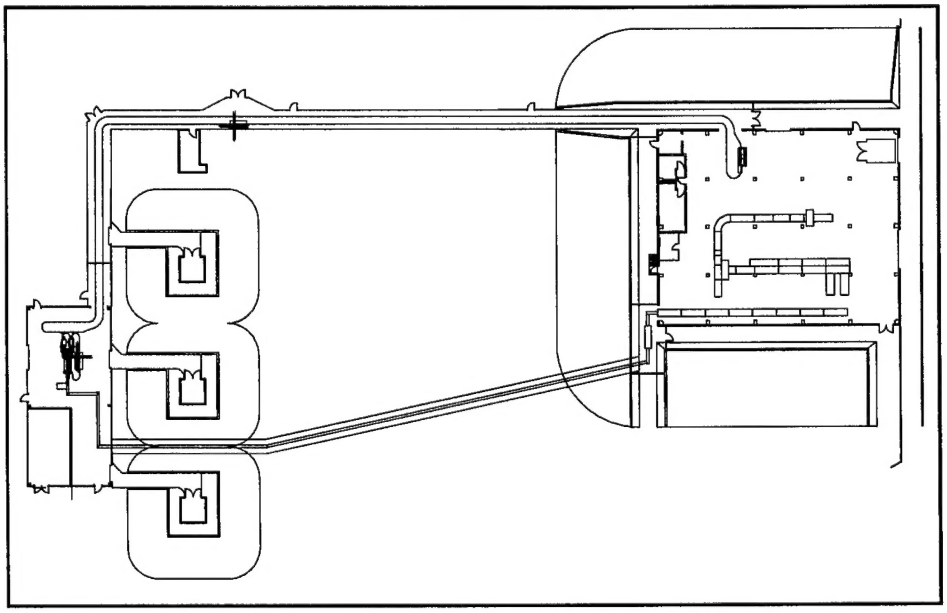

Figure 2-2. C-4 Extrusion Facility

The traditional alternative to detonation was to remove the bomb base during a remotely con-

trolled operation. This required a large bomb saw, a remote facility for the operation, and waste water treatment facilities for the resultant TNT contaminated "pink" water which was a by-product of using a water coolant during the sawing operation. Estimated facilitation cost to CAAA to use this method was $500,000.

CAAA developed an alternate method and tool which avoided these facilitation costs and simplified the material handling of the bombs and explosives. This involved removing the nose end cavity liner instead of cutting off the bomb base. A conduit cutting tool was designed and used by CAAA to make this approach feasible. The cutting tool is inserted into the nose cavity liner and manually cuts the swaged tubing to allow subsequent removal of the explosive. Coolant water is run through the conduit during cutting to eliminate heat buildup and prevent sparks. This does not result in the contaminated "pink" water, as did immersion during the previous process. It was also deemed a safe operation that did not require remote processing since the cutting occurred internally to the tube in a water environment. Therefore, it could be performed in the same facility as the subsequent Tritonal removal process.

Development of the cavity liner cutting tool to remove the nose end cavity liner and the Tritonal explosive avoided up to $500,000 in facility costs, reduced material handling exposure by 50%, and avoided contaminated "pink" water generation. In addition, the cutting operation and reduced material handling significantly reduced risk and increased safety for the program. Through this process, the M117 bomb demilitarization program was completed successfully by the end of 1996.

Explosive Pumps for Autoclaves

Previously, molten explosive extracted from the Autoclave Bomb Meltout System was manually carried to the cooling tables to await cycling through the flaking machine, causing hazardous vapors and the possibility of severe burns to employees. Crane Army Ammunition Activity resolved these problems by designing and creating the Pneumatic Chamber Pump Explosive Transfer System.

Previously, molten explosive extracted from the Autoclave Bomb Meltout System (autoclave) had to be manually carried to the cooling tables to await cycling through the flaking machine. Explosive residue was always present under the autoclave during operation, and vapors were dispersed directly into the facility violating hazard regulations. Since it was a manual operation, the employees were also exposed to the possibility of severe burns from the 220° F sediment while transporting it to the cooling tables.

Crane Army Ammunition Activity (CAAA) resolved the problem by designing and creating the Pneumatic Chamber Pump Explosive Transfer System. The molten explosive flows down from the autoclave, as before, into a continuous pneumatic pressurized collection system where it is siphoned through the exit port to the cooling table (Figure 2-3). The pump is equipped with duel exit ports should one become blocked, and the inlet port is equipped with a butterfly valve to prevent any feedback of molten explosive. The entire operation is now solidly piped

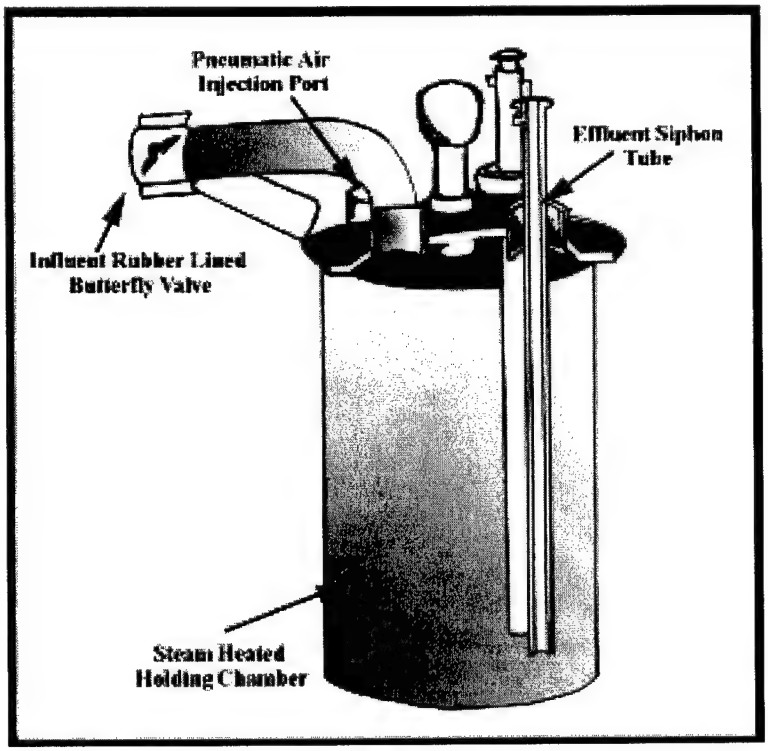

Figure 2-3. Explosive Pump for Autoclaves

to capture any vapor, which is evacuated from the facility.

This design required modification to the facility since the original molten explosive exit ports were intentionally only 10 inches from the floor to decrease the amount of splatter caused by the manual method. The other option would have been to raise the autoclave and the ceiling of the facility at a cost of $1.5 million versus the $32,000 cost of the design/development of the pneumatic pump. The installation of the pneumatic pumps saved money on the costs of renovating the facility, corrected hazardous deficiencies, and reduced the number of employees required to perform this task from four to one.

Mine Clearing Line Charge

Crane Army Ammunition Activity pursued several initiatives to improve quality, reliability, and efficiency since the 1996 Mine Clearing Line Charge Renovation. These improvements have been exported to other facilities and resulted in better reliability and less rework, with rejections virtually nonexistent.

Crane Army Ammunition Activity (CAAA) started renovating the Mine Clearing Line Charge in 1996. The Mine Clearing Line Charge is a 350-foot long explosive line, which is fired out to its full length and detonated to clear a path through mine fields. Since 1996, CAAA has completed several renovation and conversion programs involving more than 1,000 line charges, and will be initiating a new program for 740 line charges in July 2000. There were significant problems weaving the line charge during the first program, which resulted in significant levels of rejects and rework. CAAA pursued several initiatives to improve quality, reliability, and efficiency since the 1996 program.

Originally, the weaving of the arming wire and the reaming of the fuse connector were problematic and resulted in the necessity to rework the 1996 shipped quantity. The employee manually positioned the line charge and held the knurled nut while weaving the arming wire with alternate tucks over and under the arresting cable strands. The fuse connector front was located and a hole was manually drilled in the vertically-held connector. These operations were difficult to perform repetitively and resulted in drill chip debris and unacceptable weaving with damage, cut, or exposed electrical wires on the arresting cable.

In 1999, fixtures were developed to aid the operator in repetitively performing both the arming wire weave and the fuse connector reaming operations. The arming wire weave fixture was developed and implemented as a result of an employee's suggestion. This process placed the arresting cable into the holding fixture and assured that the knurled nut was correctly positioned, freeing the operator's hands to complete and inspect the weaving operation. This simple fixture was extremely effective in eliminating rework and rejections and, as a result, was exported to other ammunition facilities (Hawthorne and McAllester) for use on similar programs. The fixture, which was developed for reaming the fuse connector, also eliminated problems such as oversized holes and debris. The employee now attaches the fixture, inserts the fuse connector, and accurately drills a perpendicular hole allowing debris to fall away from the line charge. Another improvement in efficiency and material handling is planned for the conversion program starting in July 2000. This process will use a rotating spool to remove the line charge from the container and position it for the next operation, resulting in easier work for the operator (less back strain, bending, pulling), and less space and personnel requirements.

CAAA has demonstrated a continuous improvement philosophy on this program resulting in improved methods of renovating and converting the Mine Clearing Line Charges. These improvements have been exported to other facilities and resulted in better reliability and less rework. Rejections are now virtually nonexistent. Production rates have increased from a maximum of 20 per day to more than 75 per day, and planned improvements in material handling are expected to produce more efficiency and less risk of injuries to employees.

One-Stop Machine Shop

Crane Army Ammunition Activity's machine shops offer the customer unique resources not available at any other Department of Defense installation. Multiple capabilities such as Computer Aided Design / Computer Aided Manufacturing, reverse engineering via video imaging, waterjet cutting, powder coat paint, and rapid deep draw technology offer one-stop opportunities for the customer.

Crane Army Ammunition Activity's (CAAA's) machine shops offer the customer unique resources not available at any other Department of Defense installation. Multiple capabilities, such as Computer Aided Design/Computer Aided Manufacturing, reverse engineering via video imaging, waterjet cutting, powder coat paint, and rapid deep draw technology offer one-stop opportunities for the customer.

CAAA is the only Department of Defense installation with rapid deep draw technology capabilities. The 125-ton press is computer controlled and fully automatic. It has upper and lower cylinders that travel in opposing directions with specially built tooling to form a can from a round disk in about 11 seconds. The method is a three-step process referred to as draw-reverse-redraw. During the reverse operation, the canister is actually inverted into itself. Only one set of tooling is required to produce a canister to size and tolerance in a single cycle, whereas conventional drawing requires multiple sets of tooling and multiple draws for a single can.

Reverse engineering capability was recently acquired by the machine shop in the form of a computer controlled flat-part scanning machine. The machine will scan material up to 46" by 70" by ½" thick in less than two minutes, and will automatically generate full documentation including color-coded dimensions and statistical process control reports. This code can be post-processed, and the machine shop can be cutting to these specifications the same day. Many of the cutting machines in the shop can share identical workloads through post-processing of various software codes into computer numerical control language. Post-processed code allows CAAA to utilize similar machines to perform the same tasks. This capability prevents work stoppage due to machine breakdown.

All metal fabrication machines are maintained through contracted maintenance support. The contract requires a 24-hour response time, and the contractor furnishes all needed parts and tools for repair. The contractor is required to be trained on all existing equipment under the contract. This frees up CAAA's maintenance personnel to support the mission, eliminates procurement lead-time, and prevents downtime of the equipment. The response time the machine shop offers the customer is highlighted by the capabilities available. The reduction in labor, space, equipment set-ups, and equipment downtime allows efficient production of customer requirements. Rapid deep draw technology is 30% more economical than conventional drawing for like materials.

Silver Recovery

Crane Army Ammunition Activity personnel improved silver recovery and eliminated hazardous waste generation with the installation of two low-cost commercial-off-the-shelf products. The payback period for this equipment was less than one year. In addition to the environmental benefits, the annual savings gave this project less than a six-month payback on expenses.

Crane Army Ammunition Activity (CAAA) personnel improved silver recovery and eliminated hazardous waste generation with the installation of two, low cost, commercial-off-the-shelf products. In addition to the environmental benefits, the $23,421.96 annual savings gave this project less than a six-month payback on expenses. In the past, the x-ray facility, the processing of radiographic film, and the photographic processing generated 1,650 gallons of effluent annually. This effluent was considered hazardous due to its heavy metal content (silver) exceeding five parts per million. The system had an electrolytic recovery system but was unable to remove adequate contaminates, thus requiring further treatment methods. The drums of liquid hazardous waste were expensive to handle, store, and dispose by a licensed agency. CAAA develops 38,000 14" by 17" negatives annually generating 36 55-gallon drums of liquid hazardous waste which costs more than $9,900 for disposal. The labor to fill, move, store, and monitor the drums of hazardous effluent required over 100 hours of labor each year, and the lost revenue from unclaimed silver exceeded $13,000 annually as well.

A team of concerned employees identified a commercial-off-the-shelf two-stage (combined electrolytic and metallic reactive) filtration system that could remove enough metals to bring effluent below the five parts per million required by the Environmental Protection Agency to allow effluent discharge to the local Government Owned Treatment Works. The compact units reclaim enough silver to purify the effluent, and the silver can be marketed for $4.77 per troy ounce. This two-stage filtration system was purchased for approximately $3,000 and has reduced the labor needed to collect, transport, and administer the hazardous materials sav-

ing over 100 hours per year, eliminating 30 drums of hazardous waste, and generating $12,900 in the sale of silver. In addition to the environmental considerations, this filtration method produces annual savings of $23,421.96 and has amassed a three-year savings of $70,265.88.

Soil Sediment Ponds

Crane Army Ammunition Activity's Demolition Range experiences soil erosion problems every time it rains. By building a series of soil sediment ponds on all downward slopes, runoff water is filtered more than once before reaching the valley. The pond highest on the hill filters the majority of the silt, and the next one or two ponds filter the remaining silt.

Sediment ponds are used to reduce soil erosion problems at Crane Army Ammunition Activity's (CAAA's) demolition range. CAAA's demolition range personnel, equipment operators, and supervisor planned and built a successful multiple-tiered sediment pond scheme that eliminated the need for contractors, better utilized current equipment, enhanced wildlife, improved runoff water quality, and enhanced community public relations.

CAAA's demolition range experiences soil erosion problems every time it rains. The loose soils from tractor work and the detonations are washed downhill creating the need for sediment retention ponds to stop the water long enough for the soil to settle out of the water. The Environmental Protection Agency considers water that is laden with soil content and flows into waterways a form of pollution. CAAA's past practice was to hire contractors to build retention ponds in the valleys below the demolition areas to capture the soils and, when required, hire general contractors to transport soil back to the hilltop. Hiring contractors was problematic for several reasons: contractors were often in the way of CAAA's demolition mission; they tried to work the project during rainy months; and they failed to accomplish the task with undersized equipment in the time allotted.

CAAA's demolition range personnel and equipment operators are local landowners in the surrounding community and are cautious stewards of the land. The foresight of this workforce and their environmental beliefs drove the decision to reutilize CAAA's own equipment and operators to build multiple-tiered ponds and move the soil back up the hill during ongoing normal disposal operations. By building a series of ponds on all downward slopes, runoff water is filtered more than once before reaching the valley. The pond highest on the hill filters the majority of the silt, and the next one or two ponds filter the remaining silt. Equipment is better used to retrieve eroded soil because the first pond is so close to where the soil originated.

The benefits of the current practice include:

- Soil reclamation for reuse
- Elimination of costly private contracts
- Enhanced wildlife habitat
- Discharge of water into streams meets Environmental Protection Agency standards reducing the possibility of costly fines and promoting positive community public relations.

Subpart X/Corrective Action Core Team

In the latter part of 1997, U.S. Navy Southern Division and the Environmental Protection Agency came to the conclusion that the Subpart X/ Corrective Action efforts at Crane Division, Naval Surface Warfare Center needed improvement. All the agencies involved in Crane's environmental program agreed that a partnership agreement should be implemented. A Subpart X/ Corrective Action Core Team was established to discuss and resolve problems.

Environmental regulations and regulators can absorb countless hours of oversight annually for any facility that utilizes hazardous materials within their operations. Crane Army Ammunition Activity has had difficulty resolving Subpart X and Corrective Actions environmental issues during the past 11 years because of the lack of a common goal from all interested parties. The solution was to have all affected stake holders participate in an integrated product team initiative with regulators to ensure hazardous waste permitting issues and corrective action activities are undertaken in an efficient and timely manner.

In the latter part of 1997, U.S. Navy Southern Division and the Environmental Protection Agency decided that the Subpart X/Corrective Action efforts at Crane Division, Naval Surface Warfare Center needed improvement. Crane was making little progress in cleanup efforts, and the Subpart X permit application process was not nearing completion despite nine years of effort. The Environmental Protection Agency Resource Conservation and Recovery Act Subpart X identifies regulations for op-

eration of open burning/open detonation facilities. All agencies involved in Crane's environmental program agreed that a partnership agreement should be implemented. Both the Subpart X and the Corrective Action (clean-up) programs shared similar problems, such as affected agencies not communicating effectively, no formalized method to record decision-making priorities or timelines, and no metrics to define progress. The solution was to establish the Subpart X/Corrective Action Core Team. The team was kicked off in September 1998 in Indianapolis, Indiana with all affected parties meeting for a two-day facilitated partnership training session. The meeting led to the formation of a Core Team involving Region V Environmental Protection Agency; Navy Southern Division; Crane Division, Naval Surface Warfare Center; CAAA; and the Indiana Department of Environmental Management. A management team was also developed involving higher level managers from the affected agencies to act as advisors or barrier busters. The Core Team uses monthly teleconferencing meetings to discuss issues and solutions, and meets face-to-face quarterly to foster continuity in the group. All decisions on schedules, priorities, and funding are made using a consensus-based decision process. To date, no issues have been elevated to the management team for resolution.

Following a nine-year delay, the Subpart X permit was issued 16 months after the formation of the Core Team. The Core Team has provided a means for focusing the efforts of the member organizations to improve Crane's environmental programs. Each organization has a clear view of current efforts, future outlook for projects, availability to discuss issues with the pertinent players in attendance, and most important, a means to measure the progress of the cleanup program.

White Phosphorus Conversion

In 1989, Crane Army Ammunition Activity proceeded with the creation and operation of a white phosphorus conversion facility that converts solid white phosphorus material into phosphoric acid by first penetrating the container and allowing the oxygen-activated material to smolder. This is the only facility of its kind in the Americas, having the capacity to consume 11,550 pounds of white phosphorus per day.

In the demilitarization of white phosphorus munitions, three recognized methods for disposal existed: (1) open burn, (2) open-detonation, and (3) off-shore dumping. None of these methods took the effects on the environment into consideration, and they lacked any payback incentives on invested labor dollars.

In 1989, Crane Army Ammunition Activity proceeded with the creation and operation of a white phosphorus conversion facility. This facility converts solid white phosphorus material into phosphoric acid by first penetrating the container and allowing the oxygen-activated material to smolder. A conveyor belt system then feeds the container into a natural gas-fired furnace to accelerate the extraction process. The internal walls of the rotary furnace have spiral ribs which guide the container through a cycle that allows time for the material to be fully defused from the container in the form of acidic smoke/fumes. These fumes are drawn away through a heat exchanger and collected in a series of cooling towers with internal water mist. The combination of cooling and the addition of the water mist solidify the fumes as phosphoric acid, thereby recouping 75% of the material input. The empty container is then ejected at the opposite end of the furnace and recycled.

This is the only facility of its kind in the Americas (Figure 2-4). It has the capacity to consume 11,550

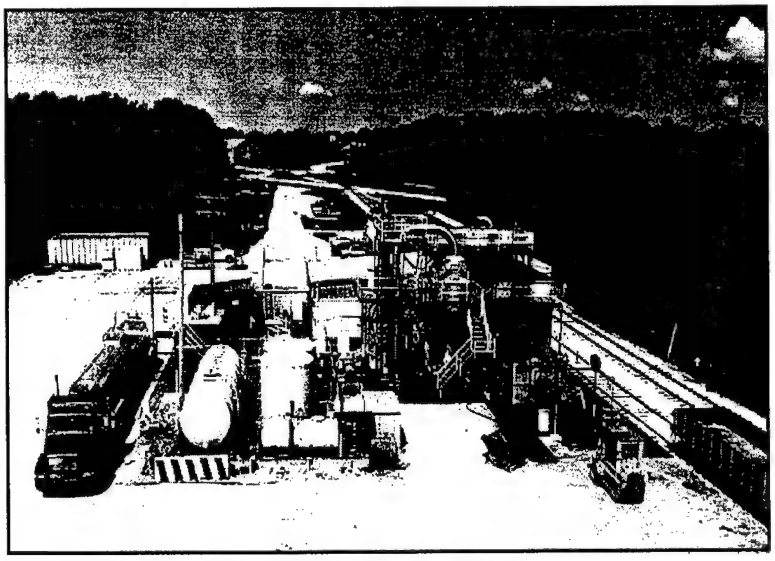

Figure 2-4. Demilitarization White Phosphorus Conversion Facility

pounds of white phosphorus per day, producing 3,640 gallons of phosphoric acid per 10-hour shift. Current capabilities accept any white phosphorus round from the size of a grenade to a 155mm projectile. Both the phosphoric acid and the metal are recycled leaving no waste by-products.

Facilities

Energy Savings Performance Contracts

Crane Army Ammunition Activity established a contracting method to maintain and update its boiler operations in a manner that allows appropriated funding to be used in a new way. A partnership between the Activity and its host, Crane Division, Naval Surface Warfare Center, resulted in the commemorative signing of the Center's first Energy Savings Performance Contract.

Crane Army Ammunition Activity (CAAA) established a contracting method to maintain and update its boiler operations (for production and heating) in a manner that allows appropriated funding to be utilized in a new way. The existing equipment required constant maintenance and caused boiler downtime. The new method sets up a mortgage-type account that allows existing funding dollars to be used for the installation and maintenance of new equipment.

Due to fiscal budgeting constraints, CAAA was not able to purchase new boiler equipment needed to reduce the maintenance costs of operation. Funding was only available for the constant maintenance of existing equipment. This method caused excessive downtime and, over time, was costing more than replacing the equipment with new low maintenance equipment. Through the use of the Commerce Business Daily, CAAA found a contractor to set up a mortgage contract, allowing the purchase of new equipment over time which accommodated the fiscal budget constraints. The new contract allows for the current budget to purchase new equipment and eliminates the downtime of the old equipment.

A partnership with CAAA and its host, Naval Surface Warfare Center Crane, resulted in the commemorative signing of the Naval Surface Warfare Center's first Energy Savings Performance Contract on July 16, 1997. The contract is used to achieve energy savings goals of Executive Order/ 12902. The contractor pays all up-front costs for design, purchase, and installation of new energy efficient systems. Over 20 years, the government repays the contractor from utility budget savings realized by the installation of the equipment. The cost savings over a 20-year period will be $447,015 and the operational availability time has increased.

Material Movement

During the past 10 years, Crane Army Ammunition Activity's Depot Operations Directorate has been addressing and solving problems pertaining to material movement. A contributing factor to the Directorate's success has been the joint teaming effort between the Activity and the Navy to implement low tech, highly effective material movement practices that have produced significant benefits.

An important part of Crane Army Ammunition Activity's (CAAA's) mission includes the receiving, storing, and shipping of conventional ammunition. With more than 1,800 storage buildings and magazines nestled within 100-square miles of property and over 200 production buildings all interconnected with an array of 150 miles of rail and 450 miles of roads, ammunition material movement is not only a challenge but must be performed safely and efficiently. CAAA has a total storage capacity of 650,000 short tons of ammunition. In 1999, CAAA received and shipped 96,000 tons of ammunition without incident and with a 98.8% on-time delivery rate. Continuous improvement is evident throughout the material movement operations.

In the 1940s, the buildings, magazines, and production buildings at CAAA were designed for the smaller trucks and the popular rail cars that existed during that time. Today, truck transportation usually offers the best price, flexibility, safety, and speed over shipping by rail; however, today's larger truck size also offers a set of unique loading and unloading challenges that did not exist before, such as smaller loading zones for the large trucks, varying dock heights, and the existence of only rails as there were no roads to some of the magazines.

During the past 10 years, CAAA's Depot Operations Directorate has been addressing and solving these problems. A contributing factor to the Directorate's success has been the joint teaming effort between the CAAA and the Navy to implement low tech, highly effective material movement practices that have produced significant benefits. Three such practices are described below:

- Material Movement Specialty Trucks — Specialty Trucks are conventional trucks that have been modified. Two types of Specialty Trucks have been designed and put into use. The first type is the Stake Trailer which is set up for both low and high dock loading and unloading, and the second type is the Road Railer which can either operate on railroad tracks or haul explosives over the road. A total of 12 specialty trucks is in operation. Most operations can now be performed with a two-man crew versus the three- or four-man crew required in the past. Most material designated for shipping can be on the road in less than four hours after it is requested. First year savings was $230,000 as a result of the Specialty Trucks.
- Material Movement Extended Reach Forklifts — Extended Reach Forklift Trucks are forklift trucks that have been fitted with a telescopic arm that extends out 20+ feet. The extended reach allows material to be directly loaded and unloaded into containers on bogie trailers without the need of a ramp and a forklift entering the container resulting in approximately 0.5 man-hour savings per container. A total of 10 extended reach forklift trucks is in operation. All bogie container loading and unloading operations can now be performed more efficiently, safer, and with quicker reaction time.
- Material Movement in High Explosive Areas — The use of a ramp and a spark proof, clean-burning diesel forklift have replaced the two electric forklifts previously required for loading and unloading material from magazines onto trucks in a high explosive area. The utilization of the ramp eliminates the need for an electric forklift on the truck and replaces it with a clean-burning diesel on the ground. It also eliminates the need for the truck to back into the narrow loading area in front of the magazine, allows direct loading and unloading, and eliminates double handling. Ramps can be set up prior to use and left at the magazines. Downtime is eliminated because the diesel forklift does not require battery replacement. The use of ramps and diesel forklifts allow the material movement operations to be performed more efficiently, safer, and with quicker reaction time.

With these improvements and more to come, CAAA has improved its overall capacity and capability to move ammunition to and from any building, magazine, and production building by truck or rail in a highly efficient and safe manner. Current reaction time is less than four hours. The overall goal is just-in-time delivery which is being quickly approached.

Management

Activity Based Costing Tool

Crane Army Ammunition Activity used a Coopers & Lybrand activity based costing model as its tactical approach to identifying organizational processes which could be reviewed for improvement. This allowed the Activity to approach ISO-9002 certification and post-certification activities across all critical core business processes.

Crane Army Ammunition Activity (CAAA) set a strategic goal of becoming ISO-9002 certified to enhance its competitive edge. Beginning in July 1997, CAAA leaders and organizational members decided to begin the process of meeting the International requirements for ISO-9002 certification. In March 1998, Perry Johnson Registrars, Inc. performed an initial certification visit at CAAA. CAAA became ISO-9002 registered in the Manufacture, Storage, Demolition and Shipment of Ammunition and Related Components in October of the same year.

Notably, CAAA utilized a Coopers & Lybrand activity based costing model as its tactical approach to identifying organizational processes which could be reviewed for improvement. This allowed CAAA to approach certification and post-certification activities across all critical core business processes. More specifically, activity based costing data helped CAAA review critical ISO-9002 elements. CAAA has built a strong internal ISO-9002 knowledge base, with 10 trained ISO-9000 lead auditors and 18 ISO-9000 auditors to maintain the edge it achieved through certification. While the goal has been to gain work, the benefits have spilled over into improved product quality and morale, reduced costs, and a work uniformity that creates a more organized work site and organization. Reaching for and obtaining ISO certification has caused CAAA to establish a more refined approach to documentation, which has led to an improved ability to find and correct process glitches.

CAAA's quality program also includes statistical process control training and implementation as part of its focused plan. The ISO-9000 auditor

training positions CAAA well for continued registration by having an internal core body of knowledge from which to leverage. Along with auditors, the lessons learned from the activity based costing model will continue to improve processes in readiness for the ISO-2000 Program. As the ISO-2000 Program nears, it will include performance metrics and the demonstration of process improvement as requirements. CAAA has built a strong foundation to continue ISO recertification efforts, integrating these new requirements more easily into its approach to the ISO-9002 program.

Appraisal Teams

In October 1998, Crane Army Ammunition Activity implemented Appraisal Teams to change the employee rating system. A weekly evaluation meeting is held with all supervisors to discuss good and bad employee performance. The Appraisal Team meetings help supervisors recognize strengths of an employee and identify areas where an employee needs improvement.

Crane Army Ammunition Activity is constantly moving employees to different work sites and jobs within the employee's technical expertise. Previously, employees were given annual performance ratings by the supervisor they worked for most during the past 12-month rating period. This system had many problems and resulted in employees not receiving the rating they deserved. Some employees who did not perform well for most of the year, but did perform satisfactorily for the supervisor they worked for the longest, would receive a satisfactory rating even though the majority of their work did not deserve that high a rating. Employees who performed outstanding jobs most of the year, but were in a position the longest where they only performed satisfactorily, would receive a satisfactory rating. Management recognized that changes were needed to improve the appraisal process.

In October 1998, Appraisal Teams were implemented to change the rating system. A weekly evaluation meeting is held with all supervisors to discuss employee performance and is recorded on a form that is a part of the employee's appraisal record. This record is then used at the time of the official rating, so that employees are rated based on the entire year rather than a portion of the year.

The Appraisal Team meetings help supervisors recognize the strengths of an employee and identify areas where an employee needs improvement. The employees can receive training in weak areas or obtain counseling for poor work habits. The joint meeting of supervisors allows other supervisors to provide input and get to know the capabilities of the employees. The appraisals are fair since every supervisor has input into the employee's rating, and employees are satisfied that the rating is fair because it is a compilation of ratings from multiple supervisors. The supervisors feel more confident in the rating knowing that the other supervisors have agreed with the overall rating.

The Appraisal Team process has dispelled the notion that some employees receive high ratings because they are the supervisor's favorites, and that low ratings are the result of a supervisor's dislike of an employee. The employees are confident that the new appraisal process is fair, and morale and work performance have shown improvement.

Flexible Workforce

Crane Army Ammunition Activity needed a better way to provide a win-win situation for both the Activity and the workers who were hired to maintain a competitive edge within workload peaks and valleys. Crane Army Ammunition Activity adopted a flexible workforce approach, hiring workers, as needed, on an intermittent work schedule. Two types of work schedules were implemented: an intermittent schedule and a full-time work schedule.

Prior to 1987, temporary full-time workers supplemented Crane Army Ammunition Activity's (CAAA's) fluctuating workload needs. These employees helped during peak workload periods by performing short-run jobs not requiring trained specialists and filling in behind permanent employees taking vacation or using Holiday leave. The biggest drawback to the method of supplementing CAAA's workers was the hiring and terminating that occurred because production schedules did not provide steady requirements to maintain temporary workers on a full-time basis.

CAAA needed a better way to provide a win-win situation for both the Activity and the workers who were hired to maintain a competitive edge within workload peaks and valleys. CAAA adopted a flexible workforce approach, hiring workers as need on an intermittent work schedule. Two types of work schedules were implemented: (1) an intermittent (on-call) schedule and (2) a full-time work

schedule. On-call employees are contacted to work when workload is available and are sent home when the work is completed. When the workload is determined to continue for several consecutive weeks, a full-time work schedule is initiated. CAAA managers have the discretion to change work schedules as workloads shift. All flexible workers are hired initially on the intermittent work schedule. Flexible workers can be converted to full-time schedules when the workload warrants, or if workload diminishes due to parts shortages or maintenance problems, an action is submitted to the Personnel Office to reverse the work schedule to intermittent.

Flexible workers must meet the same requirements as permanent employees and be fully qualified, meet all physical and medical qualifications, and be respirator qualified. Intermittent work schedule employees are paid for the hours they work, but are not entitled to benefits. Full-time employees are entitled to benefits such as accrued leave, Thrift Savings, and the election of health and retirement benefits.

Once in the flexible workforce, employees enter a pool, being assessed the number of hours equivalent to the employee in the pool with the highest number of hours worked. There are two ways to determine employees' work schedules: (1) intermittent schedule employees are called in by the lowest number of hours worked, and (2) full-time employees are called in on the basis of their service computation date. Seniority is used to convert intermittent employees to full-time. A reverse procedure is used when the workload is completed. For employees on an intermittent schedule, those with the highest number of hours are sent home first. To ensure that CAAA retains the flexibility to support workload fluctuations, employees who decline work are assessed the number of hours offered. After three such declinations, they are no longer called.

These guidelines have been developed to provide a win-win situation for both CAAA and its flexible workforce. CAAA values its pool of talented, professional, and well-trained workers who provide the balance required to meet workload fluctuations. The generic position description — explosives handlers — allows all employees to work on either manufacturing or depot storage as work requirements dictate, making them a tremendous asset to CAAA. Their contribution to the Activity comes in the form of cost savings, work schedule flexibility for managers, a readily available pool of 150 people, and surge capability without interruption.

Military Reserves

Crane Army Ammunition Activity uses military reserves in non-ammunition type activities by involving their services in the facilities/grounds repair and maintenance activities and conventional ammunition handling.

Whenever possible, Crane Army Ammunition Activity (CAAA) accomplishes tasks that otherwise could not be performed with its limited resources by calling in the military reserves to perform certain jobs. To date, jobs have included facilities/grounds maintenance and repair and conventional ammunition handling. Military reserves have been used at CAAA since 1978, but not always to full advantage. This changed in 1992 when CAAA became involved with the Golden Cargo project, an Army Industrial Operations Command initiative. The Golden Cargo project accomplishes the strategic relocation of ammunition by using military reservists.

In 1997, CAAA initiated an aggressive use of military reserves in non-ammunition type activities by involving their services in the facilities/grounds repair and maintenance activities. Both initiatives are ongoing and have benefitted CAAA in maintaining its core mission. The use of military reserves in CAAA's industrial operations provides a strong training ground and is being encouraged by the U.S. Military Services. With downsizing in the Army Industrial Operations Command and CAAA, the use of reservist manpower helps augment these reductions. Projects must be selected so that they can be matched up with the qualifications, schedules, and availability of the reservists. All branches of the Armed Services contribute to the pool from which reservist selections are made.

CAAA is responsible for identifying the tasks to be accomplished, required training, job oversight, materials, accommodations, and meals. Labor is free to CAAA, but the reservist's time on the job must be verified and reported to the reservist's unit. Typically, the reservist is available for two consecutive weeks per year or the equivalent in weekends. The Golden Cargo projects include:

- Movement of 1,260 MILVANS from Senneca Army Depot to CAAA for storage was completed in 1998 at a savings of $2.3 million.
- Palletizing and re-warehousing 14 million pounds of Composition B explosives at the Revenna Army Depot and CAAA will be completed in June 2000 at an estimated savings of $790,000.

- Assisting CAAA Quality Assurance in accomplishing 2,400 safety-in-storage inspections is planned and estimated to save $540,000.

The Facilities and Grounds Department is responsible for maintaining and repairing over 200 buildings, 1,800 magazines, 150 miles of rails, and more than 500 miles of roads within a 100-square mile property with a budget limited to $7.5 million per year. The use of military reserves is becoming an even more essential need as budgets are constrained and workload increases. Project selection is based on core mission requirements and approved by the Army Commander. The following projects completed from July 1997 through May 1999 produced a savings of $517,000 by using military reserves for the following:

- Renovation of buildings #156 and #2531
- Movement of the extruder process from the Louisiana Army Ammunition Plant
- Construction of magazine access roads
- Railroad repair
- Clearing of firebreaks.

Golden Cargo and facilities/grounds maintenance have realized tremendous benefits by using military reserves. Future plans call for additional tasks to be identified and submitted to capture military reserve manpower.

Safety Awareness Month

Crane Army Ammunition Activity devotes the entire month of February to conduct all mandated safety training required for the year and to look at all safety issues. During the month, directorates also perform other safety training on their own, and conduct scheduled downtimes to review safety in the work areas.

Crane Army Ammunition Activity (CAAA) devotes the entire month of February to conduct all mandated safety training required for the year and to look at all safety issues. During the month, directorates also perform other safety training on their own and conduct scheduled downtimes to review safety in the work areas.

In the past, safety training was performed at many different times throughout a given year. Certain types of training are required each year and different employees require different types of training depending on where they work. As a result of the different needs, delivering the required annual training placed a burden on the entire Command. Training was sporadic and different production areas were shut down at different times to receive the training, thus impacting Command effectiveness throughout the year. Also impacted was the Safety Office's ability to stay focused on its primary goal of preventing accidents because of the workload involved to prepare, coordinate, and deliver the required training at numerous times throughout the year. Another factor that contributed to the problem was the changing workload and the movement of employees from building to building to perform the work. Tracking which employees received what training and scheduling the type of training required placed additional burdens on the Safety Office as well as the first line supervisors. For example, the Safety Office could provide training at one building and three months later provide training at another building, often with some of the same employees receiving duplicate training and others missing the training.

In 1993, CAAA adopted the Safety Awareness Month, where all required annual safety training is delivered during the month of February. Instead of trying to schedule downtimes for different areas during different times of each year, all supervisors and employees now know in advance when the downtime is going to be and can schedule for minimal disruption to production. February was selected because historically it was the month of least workload and greatest attendance by employees since they had just taken leave for the Holidays.

In early January of each year, the Safety Office and the Directorate Safety Coordinators meet to discuss training requirements, training sessions, schedule times and dates, and presenters. The schedule is sent out prior to February 1, and the sessions begin during the second week of February. In addition, each work area conducts a minimum of a 30-minute standdown to perform a safety assessment of their work site. Recommendations, corrective actions, and lessons learned are forwarded to the Safety Office in a report. Also, each Directorate conducts additional training specific to their Directorate as applicable and completes CAAA's OSHA checklist to ensure compliance.

The once-a-year Safety Awareness Month has reduced downtime in the work areas and greatly reduced the burden on the Safety Office. The number of training sessions has been consolidated from 15 to eight sessions. Tracking and scheduling

is easier, duplication is avoided, and the impact on the entire Command has been reduced. Safety Awareness Month allows for total Command involvement. Everyone is made more aware of safety and involved in some aspect of the program allowing the Safety Office more time to focus on accident prevention.

Section 3
Information

Design

Prop Charge Cut-Off Machine

Crane Army Ammunition Activity developed a method of removing Prop Charges in the demilitarization process of the 5"/38 cartridges. The equipment designed for this removal has greatly improved the process. Cost savings have been realized by the reduction of one worker through the use of this process.

Crane Army Ammunition Activity (CAAA) developed a method of removing Prop Charges in the demilitarization process of the 5"/38 cartridges that greatly improved the process. The equipment designed for this removal proved to be a great improvement in safety. Cost savings have been realized by the reduction of one worker through the utilization of this process.

The old method used to remove the Prop Charges involved the use of a Y-shaped device that pried the cap off the cartridge which was crimped on during the production process. This device proved to be inadequate in performing its function, thus requiring the worker to use a rubber mallet to assist in the removal. This labor-intensive method was causing back injuries to workers which resulted in absences and reluctance to perform this job. With the explosive nature of the charge, the use of the rubber mallet was a safety hazard as well.

CAAA developed a new method of removal with an air-operated pipe cutting machine that removes the cartridge below the crimped cap. This method allows for charge removal without the use of manual force and injuries, and restored a positive attitude in performing this job. The new method allows the process to be shortened to one operation and the number of operators required reduced from six to five. The cost to develop the machine is $30,000, realizing a savings and payback of invested dollars in one year, and a 10% increase in production rate.

Repackaging Station

Crane Army Ammunition Activity devised a method to increase safety, production, and ergonomics in the disposal/burning of ammunition. The new process uses two repackaging stations where the propellant is removed from the container via an overhead manipulator and placed in a hopper, thereby physically removing the system from the burning area.

Crane Army Ammunition Activity (CAAA) devised a method to increase safety, production, and ergonomics in the disposal/burning of ammunition. The current method requires workers to stand in the burning pans and manually lift and dump the propellants from containers that typically weigh 120 pounds, and as much as 190 pounds, into the burning pans. Although strict safety procedures are followed and no accidents have occurred, this method presents a risk to workers of extreme heat exposure. Should one of the pans accidentally ignite, no fire protection system exists in the operation. Manual lifting also presents an ergonomic problem and back injury possibilities. This method is currently being phased out and replaced with two Ammunition Burning Grounds repackaging stations which will eliminate the need to manually lift and dump propellants, saving time and money and increasing worker safety on the job (Figure 3-1).

The new process uses two repackaging stations where the propellant is removed from the container via an overhead manipulator and placed in a hopper. This system is physically removed from the burning area. The system contains a fire suppression system to counter any fires that may occur. The hopper is then moved to the burning pans via a rough-terrain, explosive-proof forklift. The self-dumping hoppers are then dumped into the burning pans. This process is approved as an Ammunition Peculiar Equipment item that passes Ammunition Peculiar Equipment regulations for this type of equipment use.

The cost of the system is $171,000 which will be recovered from reduced labor costs in one year. The current practice requires nine workers which will be reduced to seven when the system becomes fully

Figure 3-1. Repackaging Station

operational. It is also projected that CAAA will be capable of performing five burns per day as opposed to the current four increasing production. With increased safety and production, this system proves to be a great improvement over the method which is being phased out. Worker injuries will be reduced if not eliminated by using the new process.

Centralized Supply Warehouse

Crane Army Ammunition Activity's Production Operations established a central location for recurring supplies, and gave credit card authority to one individual within the organization who consolidated and purchased the recurring small dollar value items. A locally developed purchasing automated data file was initiated and maintained to facilitate the purchasing process.

Purchasing support to Crane Army Ammunition Activity's (CAAA's) Production Operations involves numerous small, and at times, repetitive orders from every department. The purchase of many low-value items (e.g., gloves, coveralls, expendables) by sending individual purchase requests to a buyer was time consuming and costly. Processing numerous small orders instead of larger combined orders required significant clerical support and was inefficient from both the buyer's and the seller's perspectives. CAAA's Production Operations recognized that using CAAA's credit card program would be a beneficial change.

Production Operations established a central location for recurring supplies, and gave credit card authority to one individual within the organization who consolidated and purchased the recurring small dollar value items. Purchases were limited to $2,500 per transaction and $25,000 cumulative per month. A locally developed purchasing automated data file, which maintained compatibility with other similar CAAA data systems, was initiated and maintained to facilitate the purchasing process.

Centralized use of the credit card authority within Production Operations enabled a small stock of recurring items to be maintained, allowed consolidation of supply purchases for all departments, and also improved standardization of supplies. As a result, significantly fewer resources were needed for the clerical and administrative work involved with processing purchase requests.

De-Fin Rockeye Bomblets

Crane Army Ammunition Activity had several production programs to demilitarize the MK20 Rockeye Cluster Bomb, and recognized that the definning operation needed improvement. The solution was found by converting three fuse-crimping machines that were previously used in manufacturing the bomblets.

Beginning in 1996, Crane Army Ammunition Activity (CAAA) had several production programs to demilitarize the MK20 Rockeye Cluster Bomb.

This consisted of removing 247 bomblets from each bomb casing, checking to see that they were not armed, removing the plastic fins, and detonating the bomblets. The plastic fins had to be cut off due to environmental concerns.

At the beginning of the program, employees would remove the bomblets, inspect each bomblet for a visible green dot which indicated that the bomblet was not armed, and use a hand cutter to fully remove the plastic fins. This was a very difficult operation to perform repetitively, and employees complained of blisters and hand and wrist injuries. The amount of manual handling also increased the risk of dropping the bomblet on its nose, which could set off the MK95 detonator. Within a few weeks of initiation of the 1996 program, CAAA recognized that the de-finning operation needed improvement. The solution was found by converting three fuse-crimping machines that had been previously used in manufacturing the bomblets. The crimping mechanism was replaced with cutters, and a limiting switch was used to safely initiate the cutting operation. When the bomblet was inserted into the de-finning machine, a dead-stop limit switch would automatically activate the cutting action. The plastic was then collected for recycling. Recycling was not possible with the previous manual cutting method since it resulted in non-plastic materials also being removed.

As a result of the automated de-finning improvement process, production was increased from 10 to 60 Rockeye Cluster Bombs (each containing 247 bomblets) per day. Safety and ergonomics were improved and the fins became a recyclable item. This process was used from 1996 to 1999 on more than 54,000 Rockeye bombs including more than 13 million bomblets.

MK8-3 Demolition Charge Loading Fixture

Crane Army Ammunition Activity manufactured a small quantity of demolition line charges and experienced a 30% failure rate due to damaged explosive pellets. A review of the first production run revealed that excessive force was being exerted as the pellets were forced through the cylindrical hose used to encase the charges. The Activity now uses the existing clamping fixture to hold the hose in place, and then cap both ends and apply enough air pressure to expand the hose beyond its original dimensional size.

Crane Army Ammunition Activity (CAAA) manufactured a small quantity of demolition line charges and experienced a 30% failure rate due to damaged explosive pellets. A review of the first production run revealed that excessive force was being exerted as the pellets were forced through the 25-foot long cylindrical hose used to encase the charges. One of the fault factors was the method in which the hose was being received from the supplier. It came in long rolls and during the course of storage and transport, the hose had become either flattened or crimped. After being pressed, the pellets were then inserted by hydraulic ram into one end of the hose. With the charge requiring 236 pellets, which were only 0.008" smaller in diameter than the receptive hose and were inserted through only one end, the combination of crimped hose and friction developed by travel distance, minimum clearance, and minor cohesion created damage to the pellets.

The solution to the problem chosen by CAAA was to use the existing clamping fixture to hold the hose in place and then cap both ends and apply enough air pressure to expand the hose slightly beyond its original dimensional size. With the hose under pressure, the pellets were then inserted through both ends of the hose using two air-driven rams. Elimination of friction by pressurizing the hose reduced pellet breakage. Also, an additional pellet holding fixture was added at both ends of the clamping fixture to accommodate one-half of the required number of pellets, so that as one charge hose was being loaded, a second charge was being prepped with pellets for insertion (Figure 3-2).

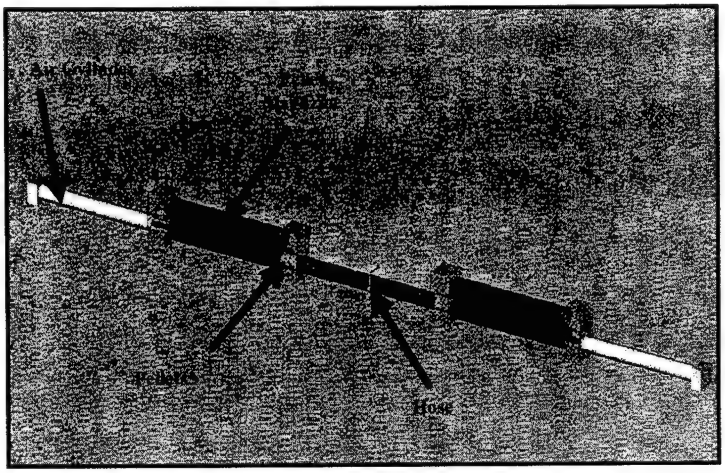

Figure 3-2. MK8-3 Demolition Charge Loading Fixture

By the end of production, this change to the production line added an additional 100 units (45 to 145) per 10-hour shift at a cost savings of $400,000. Similarly, it reduced the failure rate from 30% to 0.1% resulting in higher quality product through reduced pellet breakage.

Operator Control/Inspection Sheets

Crane Army Ammunition Activity uses Operator Control / Inspection Sheets on most maintenance and renovation product lines. A Quality Assurance Specialist uses the process operating procedures for a specific project to plan out the inspection characteristics.

Traditionally Crane Army Ammunition Activity (CAAA) used full time inspectors in each building or project line to inspect all work done by operators. This 100% quality control effort was done either hands-on or by looking over the shoulder of the operator, with the inspector having full responsibility for the inspection results and the acceptability of the product. Around 1995, the philosophy began changing to give the operator more responsibility for the quality of his work, and to move away from 100% inspections by a separate quality control person. There was also a perceived need to improve the overall quality of CAAA products.

Operator Control/Inspection Sheets are now used on most maintenance and renovation product lines. A Quality Assurance Specialist uses the process operating procedures for a specific project to plan out the inspection characteristics. These are then reflected in the Operator Control/Inspection sheets used by the operator to enter all inspection results and sign for the completeness of the operation. The quality control inspector then reviews each sheet for completeness before releasing the product. The previous 100% quality control inspection has been reduced to about a 20% sample inspection.

CAAA realized several benefits in moving away from 100% quality control inspections and requiring operators to inspect and sign for the quality of their own work. This has given operators an increased sense of pride and responsibility in the quality of their work, and quality levels (reject rates) on programs such as the Mine Clearing Line Charge and the C-4 Explosive Reclamation Project have improved. Quality control inspection resources have been reduced with inspectors sampling in multiple areas instead of being assigned full time to 100% inspection activities in each building or project line. The improved quality levels and the controlled documentation of inspection results were instrumental in CAAA becoming registered to the ISO-9002 Quality Program Standard.

Pellet Assembly

Crane Army Ammunition Activity was tasked with producing 155mm practice rounds. Since 41,000 pellets were needed to fulfill the requirements, the Activity developed a new process to meet the production requirement which reduced assembly times and labor cost.

Crane Army Ammunition Activity (CAAA) was tasked with producing 155mm practice rounds. The pellet that goes into the 155mm round had been a remote assembly operation due to safety concerns. The pellet is a high explosive that is placed into a canister that is then crimped to contain the explosive. Large presses were used for the crimping operation. The crimping operation is performed in two steps with two different sets of fixtures in two presses. The presses that were being used were so large that they could overcome the tooling and cause pressure ignition of the pellet. At times, the pellets would also become lodged in the tooling.

Since 41,000 pellets were needed to fulfill the requirements, CAAA needed to find a better and safer way of meeting the production requirement. The tooling was redesigned so that lower pressures could be used and a positive stop was designed into the fixturing eliminating the possibility of pressure ignition. Since lower pressures were required, the small Magna presses were used. The tooling was also designed to use air pressure to eject any lodged pellets. The Safety Office approved the new process as a non-remote operation.

The new process is safer, assembly times were reduced by 58 seconds per pellet, 70% of the total labor cost was saved, the production rate increased greater than 500% and quality was improved since there was less pellet breakage. The previous production rate was 50 units per hour and the new production rate is 250 units per hour after the initial process ramp-up.

Power Conveyor

Crane Army Ammunition Activity performs demilitarization on numerous types of military munitions including the handling of the 16" bag charge containers. The Activity installed a power conveyor system to transport the containers from the end point of the production line to an awaiting gondola-type rail car.

Crane Army Ammunition Activity (CAAA) performs demilitarization on numerous types of military munitions. The demilitarization handling of the 16" bag charge containers had provided a source of bottleneck during the unpacking operations. These charges were received in aluminum containers that were 5.5' long by 16" in diameter and weighed approximately 65 pounds after the explosives were removed. The original process required operators to manually remove the containers from the unpacking tables and place them on a two-wheeled dolly for transport to an awaiting gondola-type rail car where the containers were unsystematically dumped. A number of ergonomic problems arose from this operation such as strained backs, pinched fingers, and aching joints. To alleviate the problems, CAAA installed a power conveyor system to transport the containers from the end point of the production line to the awaiting gondola. The containers were then manually stacked into the gondolas to organize the storage area. This process eliminated the need for frequent movement of the gondola, decreased the number of gondolas by 400%, significantly reduced the number of injuries, and increased production from 180 to 224 units per shift.

Programmable Pouring /Weighing Scales

With the receipt of a contract in 1992 to manufacture 45,000 Simulator / Marker 875 practice decoy flares, Crane Army Ammunition Activity instituted a programmable weight measure system for the specific application of pyro-luminous material for this project.

Weighing processes for the production of aircraft-deployed signal flares at Crane Army Ammunition Activity (CAAA) had always been accomplished by weighing the materials by manual or volumetric scoops. Often the strict tolerances required by the specification could not be met using these methods.

With the receipt of a contract in 1992 to manufacture 45,000 Simulator/Marker 875 practice decoy flares for the U.S. Air Force, CAAA instituted a programmable weight measure system for the specific application of pyro-luminous material for this project. This measurement system allows precise increments of each compound to be ejected into a rotary press by automatically using a pivotal scoop. Each of the manual weighing procedures for the three compounds was delegated to individual personnel to assure accurate increments of the total mixture. With the programmable system's accuracy and automated dumping scoop, the need for two persons was eliminated and production increased by 50%. Since the unit is compact, portable, and explosive-proof, it is an added advantage to incorporate this equipment in future contracts.

Pushout/Auto Dump

Crane Army Ammunition Activity is involved in downloading white phosphorous from 5"/38 projectiles. As a result of leaks and safety and fire hazards, the Activity initiated several process changes which significantly improved equipment and safety to personnel.

Crane Army Ammunition Activity has been involved in downloading white phosphorous from 5"/38 projectiles. Originally this process was accomplished manually by screwing on a pushout adapter to the nose threads of the projectile and hydraulically extending a shaft against the adapter, which pushed out the smoke canister and projectile baseplate. In a couple of instances, the smoke canisters developed leaks of white phosphorous which generated smoke or fire when introduced into the air. This was recognized as safety and fire hazards, and the operation was shut down. As a result, several process changes were initiated.

The operation of the hydraulic cylinder was initiated from a remote location, and a hinged housing was manufactured to fit over and hold the projectile. An operator is no longer in direct contact with the pushout process and now activates the process remotely and monitors it by video, thus eliminating the potential danger to personnel. If a leak develops, the operator activates an emergency stop button remotely, and the cylinder shaft and housing automatically move the projectile to a water trough which neutralizes the leaking phosphorous until it is safely disposed.

Since implementation over a two-year period, there has been no downtime due to fires or leaks, and safety of personnel and equipment has been significantly improved.

Shock Charge Loading and Pouring

Crane Army Ammunition Activity manufactures shock charges in various sizes for the U.S. Navy. Since there was no single dedicated facility for the loading and pouring of the shock charges, a new facility was dedicated which provided improvements in total labor for the process and additional production space for other programs.

Crane Army Ammunition Activity (CAAA) manufactures shock charges in various sizes for the U.S. Navy. The setups were different for the various sizes, and no single dedicated facility for loading and pouring the shock charges existed. There were six different multi-use pouring facilities that could be used depending on their availability. Each production run required modification of the facility to accommodate the setup, and then the setup had to be disassembled to free the facility for other purposes. The molten explosive was dry mixed, melted, and poured using kettles. The explosive is sensitive to temperature variations, which causes non-uniform consistency in the mixture resulting in quality problems.

CAAA had a facility that had been placed into the lay-away-in-place program and was previously used for Rockeye bomb pouring. Management was presented with the idea of removing the Rockeye line since it was no longer needed and dedicating the pouring facilities for the shock charges. The high set-up costs for the multi-use facilities would be eliminated with this approach, and the available equipment was compatible with all of the various shock charge sizes. Management approved the idea, and the building was modified to accommodate the shock charge pouring.

The new facility provides a higher quality product since the mixing and melting kettles are on the second floor and a direct pour of the explosive can be accomplished. The piping system for the pouring is jacketed with circulating hot water in the jacket to maintain a constant temperature of the explosive during the transfer. The new process is safer because manual transfer of the molten explosive is minimized. The dedicated facility eliminated 75% of the total labor for the process since set-up and tear-down were not required for each production run. The dedicated facility also provided additional production space for other programs.

Management

Accident Review Board

Crane Army Ammunition Activity formed an Accident Review Board to process accidents involving personal injury to a worker or an occupational illness suffered by a worker resulting in at least one day lost from work. The Accident Review Board ensures recommended corrective actions are appropriate and being implemented, and that everything is done to prevent a similar accident.

Whenever an accident involves personal injury to a worker, or an occupational illness is suffered by a worker that results in at least one day lost from work, an Accident Review Board is formed to ensure recommended corrective actions are appropriate and being implemented, and everything is being done to prevent a similar accident. A Lost Workday Case is defined as any lost workday resulting from personal injury or occupational illness. In the past, the Safety Office assigned one of two Safety Engineers/Safety Specialists to investigate all Lost Workday Cases, usually averaging approximately eight such cases per year. During the investigation, the supervisor and employee were heavily involved and usually contributed to the recommendations and corrective actions, but future involvement and follow-up fell short, often because workload dictated reassignments of both to other areas and programs. There was no formal follow-up to prevent a similar accident from recurring, which was one of the primary goals of the Safety Office. Along with this, Command involvement was not formal. During weekly Command meetings and monthly safety meetings, accidents were discussed, but not much became of these discussions. The immediate supervisor and the injured employee were not present, and many of the details were unavailable.

In early 1998, the Safety Office added a formalized Accident Review Board to add more emphasis in helping review Lost Workday Cases and preventing similar accidents. Unchanged was the detailed investigation by the Safety Office and the corrective

action process. But now with an Accident Review Board added to the process, each accident is given priority attention and follow-up. The make-up of the Accident Review Board is specific for each accident and determined by the Safety Office. The Board always consists of the Commander and the Chief of the Safety Office, the Director of the Directorate where the accident occurred, the supervisor of the injured employee, and the employee. Other employees at any level may be invited to be on the Board if it is determined that they can contribute to the prevention of the accident in the future. The Board meets only after the investigation is complete and corrective action is determined. The meetings are not inquisitions, but a formalized approach to ensure that the best is being done to protect the safety of the employees against future accidents that are similar in nature. The Board ensures that a complete investigation is accomplished, discusses the status of corrective actions, and that inputs by everyone are taken into account. The frequency and number of meetings depend on the uniqueness of each case reviewed and continue until the preventive measures taken no longer require follow-up.

Since the addition of the Accident Review Board, four cases have been processed to the satisfaction of all involved, especially the employees. Repeat accidents are also receiving much needed attention. Since implementation of the Accident Review Board, the number of Lost Workday Cases is down from 11 to four per year, and the number of Lost Days has dropped from 113 to 45 days.

Commodity Teams

Crane Army Ammunition Activity formed Commodity Teams to perform its programs. The Commodity Teams consist of all divisions involved in the particular project — engineers, technicians, management representatives, and skilled operators.

Crane Army Ammunition Activity (CAAA) recognizes that the combined voice of engineers, technicians, management representatives, and skilled operators at the very beginning of their individual programs contribute to product and process improvements. Prior to 1996, their approach to cast loading, pyrotechnics, demilitarization, and ordnance renovation was done in pockets — from engineering, to planning and estimating, to supervisors, and ultimately to ordnance operators. With standard operating procedures in place, all personnel did not get heard in the process. Problems were not always identified early in the programs, resulting in work stoppages that CAAA found unacceptable.

CAAA made significant changes by using commodity teams to perform the programs. As soon as a request is made for a cost estimate, meetings are held to brainstorm the production process needed. Engineers, technicians, quality assurance personnel, safety representatives, and the commodity managers come to the work site at production startup. After only a few hours into production, the team ceases operations for a team meeting. The process is analyzed step-by-step to make any necessary adjustments.

The commodity teams consist of all divisions involved in the particular project as well as the production line operators. As a result of its team approach, CAAA can fully achieve its production rates within two days, an improvement from its historical two-week average. With little added cost to its programs, CAAA has seen both product and process improvements while gaining valuable experience for future programs. Because CAAA's programs are very unique in both project scope and duration, the commodity team approach produces high quality, shorter-duration projects. By getting everyone involved in the process, CAAA's efficiency and safety record have improved and team ownership has been achieved.

Credit Card Procurement

Crane Army Ammunition Activity implemented maximum use of the International Merchants Purchase Authorization Card in February 1996, and currently uses the system for 90% of small purchase procurements exceeding the Army's goal of 80%.

Crane Army Ammunition Activity (CAAA) implemented maximum use of the International Merchants Purchase Authorization Card and streamlined the procurement process. The previous procurement process was cumbersome and filled with delays. The procurement administrative lead time average was, at best, 60 to 90 days, and many times material substitutions were not satisfactory. A large backlog of orders built up in the contracting office due to personnel cuts from five buyers to two. Under the old method, procurement packages were sent to the contracting office regardless of dollar value. Technical packages were prepared and sent with the requisition. In order to alleviate the

problem of inadequate material being supplied as a substitute, sole-source justifications were frequently required, and there was no adequate vendor rating system in place to eliminate problem suppliers. A solicitation was prepared and awards were made generally to the low bidder. Hard copy purchase orders were then prepared and mailed to the supplier.

In 1995, Congress mandated a simplified acquisition process. CAAA implemented the International Merchants Purchase Authorization Card credit card purchase system in February 1996 and currently uses the system for 90% of small purchase procurements exceeding the Army's goal of 80%. The International Merchants Purchase Authorization Card cardholders assumed the ordering responsibilities as collateral duties. The cardholders order the material, check the status, receive the material, and balance their own procurements, thereby eliminating the cataloging, receipt, and issue functions previously required. The purchase is typically completed in one to two days, and emergency orders may be immediately picked up locally. The requestor receives the material ordered rather than a substitute and is able to dictate the quality of the material rather than the award going to the low bidder regardless of quality.

The credit card procurements are received in a more timely manner. By using the InternationalMerchants Purchase Authorization Card, receipt and issue documents and transactions have been eliminated and indirect labor costs are lower. Contracting, supply, and finance workload and backlogs have been reduced. The suppliers are paid immediately rather than having to wait long periods for payment. When the Naval Surface Warfare Center eliminated the stocking of routine supplies, CAAA was able to use the credit cards to procure the items needed. The International Merchants Purchase Authorization Card has been universally accepted by all CAAA suppliers. In 1999, 3,890 procurements were processed with a total dollar value of $1,446,204.10.

Electronic Documentation Preparation

Crane Army Ammunition Activity has become a more aggressive and agile organization because of its evolution to electronic documentation. By using personal computers, scanners, and e-mail, adjustments to technical documentation can be integrated into procedures in hours versus weeks.

Moving from a paper-based environment to an electronic documentation system has been an evolutionary process for Crane Army Ammunition Activity (CAAA). Short documentation turnaround in an ammunition production facility has always been important, but prior to 1992, industrial engineering standard operating procedures were handwritten. Industrial engineering technicians used pencil and paper to prepare these procedures, requiring extensive clerical support to convert their data into final form.

The important issue was one of non-technical personnel finalizing technical documents, leaving room for subjective interpretation and potential error in documents that required no substantive alteration. Additionally, changes and corrections that are a normal occurrence in ordnance manufacturing were burdensome. Multiple routing by hand consumed at least four to six weeks, and filing was difficult because engineering drawings had to be copied to reduce their size. The end result was that with 2,750 documents in the active file, four to five people were involved in processing a single document. The investment was heavy, and results were costly and inefficient.

Since the early 1990s, CAAA has become a more aggressive and agile organization because of its evolution to electronic documentation. Today, industrial engineering technicians prepare their own documents on personal computers, transforming work procedures from statements of work. With scanners, the integrity of drawings is maintained since they are no longer copied and reduced making them clearer and easier to work with. The impact of electronic documentation is that today, technical personnel prepare technical documentation with little need for administrative assistance. Because of e-mail, multiple routing now takes hours ratherthan days that were consumed in a paper-intensive process. With the increase in today's safety and environmental changes, these adjustments can be integrated into procedures in hours versus weeks.

A very important efficiency is the filing that is now accomplished by maintaining an electronic copy on the server. Anyone can review a procedure at the touch of his or her fingers. This has been a ten-year investment for the organization, but a total process that once took 90 to120 days, consuming the time of many people, now takes between three and four weeks, with increased effectiveness. CAAA is looking forward to its next phase of electronic documentation — transitioning from a server-based system to a web-based information environment.

Electronic Material Review Board

Crane Army Ammunition Activity's Material Review Board decides the disposition of non-conforming material. Prior to 1992, the process was driven by a cumbersome, paper-based approach. Today, the Material Review Board process is accomplished by personal computer, positively impacting the Activity's production.

Crane Army Ammunition Activity has a Material Review Board that decides the disposition of non-conforming material, whether that material is purchased or manufactured at Crane. Prior to 1992, the Material Review Board process was driven by a cumbersome, paper-based approach. An inspector would identify non-conforming material on a discrepancy record form, and the discrepancy record had to have a control number. Because a hard-copy form was used, the control number was maintained by secretarial personnel. The form was hand-carried to the supervisor, and subsequently hand-carried or mailed to individual Material Review Board members for their input, comments, and signatures. With the amount of coordination and hand-carrying involved, the process was labor intensive and subject to lost records.

Today, the Material Review Board process is accomplished by personal computer. The electronic disposition form and e-mail capabilities have decreased the need for formal Material Review Board meetings and reduced overall processing time. A total Material Review Board process that normally took two weeks has been reduced to a day or less. An inspector initiates the discrepancy record via the personal computer, forwards the electronic form by e-mail to the supervisor for review, and then forwards the electronic discrepancy record to the Material Review Board. With engineering, production planning and control, and quality assurance input and recommendations, the discrepancy record is forwarded to the Material Review Board chairman (quality assurance) who has ultimate authority to make a decision.

Beyond significant savings in processing time and the increased ability to track status, actual line stoppages have been processed in less than an hour, reducing overall downtime. The electronic discrepancy record and the personal computer process have directly impacted the Activity's production in a positive manner.

Inventory Count Crews

Crane Army Ammunition Activity has moved away from the conventional approach to inventorying ammunition by embarking on a different approach to its inventory procedure. The Activity built a system of one-person inventory count crews and implemented important measures to maintain a safe environment for the employee.

Crane Army Ammunition Activity (CAAA) has moved away from the conventional approach to inventorying ammunition. Historically, inventorying ammunition meant two people per storage site, as is the norm for most depots. Working from an inventory list at each storage site, two people working together experienced some balancing delays between counting and recording. These tasks could be handled efficiently by one person, but the trend had been to use two people to do the job. As a result, much time was spent in breaking out the tasks between two people.

In 1987, CAAA embarked on a different approach to its inventory procedure by building a system of one-person inventory count crews. Important measures have been implemented to maintain a safe environment for the employee who takes inventory in a storage facility where two people had previously performed the work. More vehicles and radios are used to communicate between sites, and a check is performed every two hours to maintain contact with workers. Work leaders assist with ladders where needed, and help when problem doors prevent easy access.

Intermittent employees are used to performing CAAA's ammunition inventory. These employees work nine months a year, and have been an integral part of this approach for the past five years. In the first year of one-person inventory crews, CAAA recorded more than $600,000 in man-hour savings. While inventorying certain munitions still requires two-person crews, the one-person count crew can be used in 90% of CAAA's inventory process. Documented man-hour savings are important; however, the buddy system and improved communication are excellent benefits in the one-person inventory crew.

Serialized Security Items

Crane Army Ammunition Activity has responded to the new requirement of inventorying and recording the Standard Depot System Category I weapon systems by serial number. The use of bar codes/ scanners and personal computers has improved the inventory process and reduced overall man-hours.

Crane Army Ammunition Activity has responded to the new requirement of inventorying and recording the Standard Depot System Category I weapon systems by serial number. Before this requirement, the Activity housed Category I items, such as launchers and cartridges, by lot number. As a result, the facility and associated process were designed for lot-type inventory, storage, and record keeping.

With the serialization requirement, buildings and inventory processes were redesigned. Aisles were adjusted for better accessibility, and bar code scanners and roller ladders were purchased to improve all inventory-related procedures. To better manage this change, the Inventory Management Division developed an Excel database so that data could be pulled from the Standard Depot System listing and formatted into grids corresponding to locations within a facility. The Standard Depot System listing is sorted by condition, owner, lot number, and serial number. The grid is sorted by lot and further by serial number.

With serial numbers scanned by bar code scanners, data is collected and stored in a personal computer. As a result, records are more accurate, easily read, and readily moved by e-mail. This proactive approach also means that more than one crew can work in a site because they have access to a specific grid rather than the whole Standard Depot System listing. Instead of spending an entire month performing inventory, 12 people can now perform the semi-annual inventory in two days. The benefits to shipping and receiving include the elimination of potential errors, the ability to maintain a more accurate database of current assets, and fewer man-hours expended in trips back and forth to verify numbers. The process has resulted in more organization and less opportunity for error. The use of bar codes scanners, combined with the improved inventory process, have reduced overall man-hours by 25% compared to the previous manual process.

Appendix A

Table of Acronyms

No acronyms were used in this report.

Appendix B

BMP Survey Team

Team Member	Activity	Function
Larry Robertson (812) 854-5336	**Crane Division** Naval Surface Warfare Center Crane, IN	**Team Chairman**
Paula Hauser (812) 854-6649	**Crane Division** Naval Surface Warfare Center Crane, IN	**Technical Writer**
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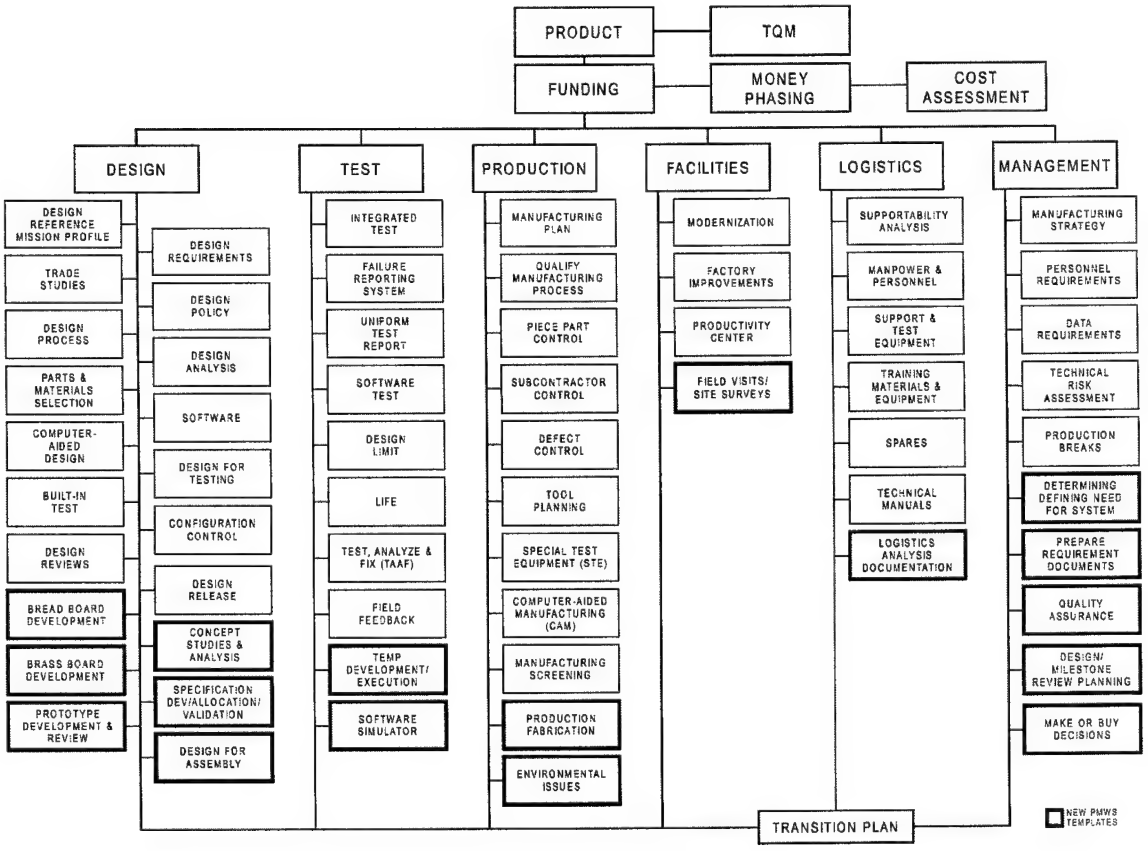
Appendix C

Critical Path Templates and BMP Templates

This survey was structured around and concentrated on the functional areas of design, test, production, facilities, logistics, and management as presented in the Department of Defense 4245.7-M, *Transition from Development to Production* document. This publication defines the proper tools—or templates—that constitute the critical path for a successful material acquisition program. It describes techniques for improving the acquisition process by addressing it as an *industrial* process that focuses on the product's design, test, and production phases which are interrelated and interdependent disciplines.

The BMP program has continued to build on this knowledge base by developing 17 new templates that complement the existing DOD 4245.7-M templates. These BMP templates address new or emerging technologies and processes.

"CRITICAL PATH TEMPLATES FOR TRANSITION FROM DEVELOPMENT TO PRODUCTION"

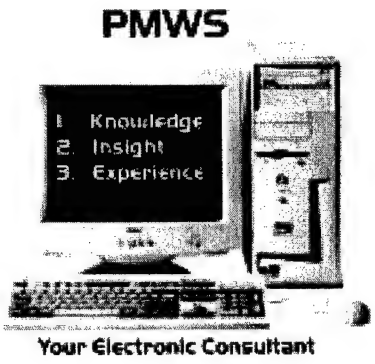


Appendix D

The Program Manager's WorkStation

The Program Manager's WorkStation (**PMWS**) is an electronic suite of tools designed to provide timely acquisition and engineering information to the user. The main components of PMWS are KnowHow; the Technical Risk Identification and Mitigation System (TRIMS); and the BMP Database. These tools complement one another and provide users with the *knowledge*, *insight*, and *experience* to make informed decisions through all phases of product development, production, and beyond.

KnowHow provides knowledge as an electronic library of technical reference handbooks, guidelines, and acquisition publications which covers a variety of engineering topics including the DOD 5000 series. The electronic collection consists of expert systems and simple digital books. In expert systems, KnowHow prompts the user to answer a series of questions to determine where the user is within a program's development. Recommendations are provided based on the book being used. In simple digital books, KnowHow leads the user through the process via an electronic table of contents to determine which books in the library will be the most helpful. The program also features a fuzzy logic text search capability so users can locate specific information by typing in keywords. KnowHow can reduce document search times by up to 95%.



TRIMS provides insight as a knowledge-based tool that measures technical risk management rather than cost and schedule. Cost and schedule overruns are downstream indicators of technical problems. Programs generally have had process problems long before the technical problem is identified. To avoid this progression, TRIMS operates as a process-oriented tool based on a solid Systems Engineering approach. Process analysis and monitoring provide the earliest possible indication of potential problems. Early identification provides the time necessary to apply corrective actions, thereby preventing problems and mitigating their impact. TRIMS is extremely user-friendly and tailorable. This tool identifies areas of risk; tracks program goals and responsibilities; and can generate a variety of reports to meet the user's needs.

The **BMP Database** provides experience as a unique, one-of-a-kind resource. This database contains more than 2,500 best practices that have been verified and documented by an independent team of experts during BMP surveys. BMP publishes its findings in survey reports and provides the user with basic background, process descriptions, metrics and lessons learned, and a Point of Contact for further information. The BMP Database features a searching capability so users can locate specific topics by typing in keywords. Users can either view the results on screen or print them as individual abstracts, a single report, or a series of reports. The database can also be downloaded, run on-line, or purchased on CD-ROM from the BMP Center of Excellence. The BMP Database continues to grow as new surveys are completed. Additionally, the database is reviewed every other year by a BMP core team of experts to ensure the information remains current.

For additional information on PMWS, please contact the Help Desk at (301) 403-8179, or visit the BMP web site at http://www.bmpcoe.org.

Appendix E

Best Manufacturing Practices Satellite Centers

There are currently nine Best Manufacturing Practices (BMP) satellite centers that provide representation for and awareness of the BMP program to regional industry, government and academic institutions. The centers also promote the use of BMP with regional Manufacturing Technology Centers. Regional manufacturers can take advantage of the BMP satellite centers to help resolve problems, as the centers host informative, one-day regional workshops that focus on specific technical issues.

Center representatives also conduct BMP lectures at regional colleges and universities; maintain lists of experts who are potential survey team members; provide team member training; and train regional personnel in the use of BMP resources.

The nine BMP satellite centers include:

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Appendix F

Navy Manufacturing Technology Centers of Excellence

The Navy Manufacturing Sciences and Technology Program established the following Centers of Excellence (COEs) to provide focal points for the development and technology transfer of new manufacturing processes and equipment in a cooperative environment with industry, academia, and Navy centers and laboratories. These COEs are consortium-structured for industry, academia, and government involvement in developing and implementing technologies. Each COE has a designated point of contact listed below with the individual COE information.

Best Manufacturing Practices Center of Excellence

The Best Manufacturing Practices Center of Excellence (BMPCOE) provides a national resource to identify and promote exemplary manufacturing and business practices and to disseminate this information to the U.S. Industrial Base. The BMPCOE was established by the Navy's BMP Program, The Department of Commerce, and the University of Maryland at College Park, Maryland. The BMPCOE improves the use of existing technology, promotes the introduction of improved technologies, and provides non-competitive means to address common problems, and has become a significant factor in countering foreign competition.

Point of Contact:
Anne Marie T. SuPrise, Ph.D.
Best Manufacturing Practices Center of Excellence
4321 Hartwick Road
Suite 400
College Park, MD 20740
(301) 403-8100
FAX: (301) 403-8180
annemari@bmpcoe.org

Center of Excellence for Composites Manufacturing Technology

The Center of Excellence for Composites Manufacturing Technology (CECMT) provides a national resource for the development and dissemination of composites manufacturing technology to defense contractors and subcontractors. The CECMT is managed by the Great Lakes Composites Consortium and represents a collaborative effort among industry, academia, and government to develop, evaluate, demonstrate, and test composites manufacturing technologies. The technical work is problem-driven to reflect current and future Navy needs in the composites industrial community.

Point of Contact:
Mr. James Ray
Center of Excellence for Composites Manufacturing Technology
c/o GLCC, Inc.
103 Trade Zone Drive
Suite 26C
West Columbia, SC 29170
(803) 822-3708
FAX: (803) 822-3710
jrglcc@glcc.org

Electronics Manufacturing Productivity Facility

The Electronics Manufacturing Productivity Facility (EMPF) identifies, develops, and transfers innovative electronics manufacturing processes to domestic firms in support of the manufacture of affordable military systems. The EMPF operates as a consortium comprised of industry, university, and government participants, led by the American Competitiveness Institute under a Cooperative Agreement with the Navy.

Point of Contact:
Mr. Alan Criswell
Electronics Manufacturing Productivity Facility
One International Plaza
Suite 600
Philadelphia, PA 19113
(610) 362-1200
FAX: (610) 362-1290
criswell@aci-corp.org

National Center for Excellence in Metalworking Technology

The National Center for Excellence in Metalworking Technology (NCEMT) provides a national center for the development, dissemination, and implementation of advanced technologies for metalworking products and processes. The NCEMT, operated by Concurrent Technologies Corporation, helps the Navy and defense contractors improve manufacturing productivity and part reliability through development, deployment, training, and education for advanced metalworking technologies.

Point of Contact:
Mr. Richard Henry
National Center for Excellence in Metalworking Technology
c/o Concurrent Technologies Corporation
100 CTC Drive
Johnstown, PA 15904-3374
(814) 269-2532
FAX: (814) 269-2501
henry@ctc.com

Navy Joining Center

The Navy Joining Center (NJC) is operated by the Edison Welding Institute and provides a national resource for the development of materials joining expertise and the deployment of emerging manufacturing technologies to Navy contractors, subcontractors, and other activities. The NJC works with the Navy to determine and evaluate joining technology requirements and conduct technology development and deployment projects to address these issues.

Point of Contact:
Mr. David P. Edmonds
Navy Joining Center
1250 Arthur E. Adams Drive
Columbus, OH 43221-3585
(614) 688-5096
FAX: (614) 688-5001
dave_edmonds@ewi.org

Energetics Manufacturing Technology Center

The Energetics Manufacturing Technology Center (EMTC) addresses unique manufacturing processes and problems of the energetics industrial base to ensure the availability of affordable, quality, and safe energetics. The focus of the EMTC is on process technology with a goal of reducing manufacturing costs while improving product quality and reliability. The EMTC also maintains a goal of development and implementation of environmentally benign energetics manufacturing processes.

Point of Contact:
Mr. John Brough
Energetics Manufacturing Technology Center
Indian Head Division
Naval Surface Warfare Center
101 Strauss Avenue
Building D326, Room 227
Indian Head, MD 20640-5035
(301) 744-4417
DSN: 354-4417
FAX: (301) 744-4187
mt@command.ih.navy.mil

Institute for Manufacturing and Sustainment Technologies

The Institute for Manufacturing and Sustainment Technologies (iMAST), was formerly known as Manufacturing Science and Advanced Materials Processing Institute. Located at the Pennsylvania State University's Applied Research Labortory, the primary objective of iMAST is to address challenges relative to Navy and Marine Corps weapon system platforms in the areas of mechnical drive transmission techologies, materials science technologies, high energy processing technologies, and repair technology.

Point of Contact:
Mr. Bob Cook
Institute for Manufacturing and Sustainment Technologies
ARL Penn State
P.O. Box 30
State College, PA 16804-0030
(814) 863-3880
FAX: (814) 863-1183
rbc5@psu.edu

Gulf Coast Region Maritime Technology Center

The Gulf Coast Region Maritime Technology Center (GCRMTC) is located at the University of New Orleans and focuses primarily on product developments in support of the U.S. shipbuilding industry. A sister site at Lamar University in Orange, Texas focuses on process improvements.

Point of Contact:
Dr. John Crisp, P.E.
Gulf Coast Region Maritime Technology Center
University of New Orleans
College of Engineering
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Appendix G

Completed Surveys

As of this publication, 120 surveys have been conducted and published by BMP at the companies listed below. Copies of older survey reports may be obtained through DTIC or by accessing the BMP web site. Requests for copies of recent survey reports or inquiries regarding BMP may be directed to:

Best Manufacturing Practices Program
4321 Hartwick Rd., Suite 400
College Park, MD 20740
Attn: Anne Marie T. SuPrise, Ph.D., Acting Director
Telephone: 1-800-789-4267
FAX: (301) 403-8180
annemari@bmpcoe.org

1985	Litton Guidance & Control Systems Division - Woodland Hills, CA
1986	Honeywell, Incorporated Undersea Systems Division - Hopkins, MN (now Alliant TechSystems, Inc.) Texas Instruments Defense Systems & Electronics Group - Lewisville, TX General Dynamics Pomona Division - Pomona, CA Harris Corporation Government Support Systems Division - Syosset, NY IBM Corporation Federal Systems Division - Owego, NY Control Data Corporation Government Systems Division - Minneapolis, MN
1987	Hughes Aircraft Company Radar Systems Group - Los Angeles, CA ITT Avionics Division - Clifton, NJ Rockwell International Corporation Collins Defense Communications - Cedar Rapids, IA UNISYS Computer Systems Division - St. Paul, MN
1988	Motorola Government Electronics Group - Scottsdale, AZ General Dynamics Fort Worth Division - Fort Worth, TX Texas Instruments Defense Systems & Electronics Group - Dallas, TX Hughes Aircraft Company Missile Systems Group - Tucson, AZ Bell Helicopter Textron, Inc. - Fort Worth, TX Litton Data Systems Division - Van Nuys, CA GTE C^3 Systems Sector - Needham Heights, MA
1989	McDonnell-Douglas Corporation McDonnell Aircraft Company - St. Louis, MO Northrop Corporation Aircraft Division - Hawthorne, CA Litton Applied Technology Division - San Jose, CA Litton Amecom Division - College Park, MD Standard Industries - LaMirada, CA Engineered Circuit Research, Incorporated - Milpitas, CA Teledyne Industries Incorporated Electronics Division - Newbury Park, CA Lockheed Aeronautical Systems Company - Marietta, GA Lockheed Missile Systems Division - Sunnyvale, CA (now Lockheed Martin Missiles and Space) Westinghouse Electronic Systems Group - Baltimore, MD (now Northrop Grumman Corporation) General Electric Naval & Drive Turbine Systems - Fitchburg, MA Rockwell Autonetics Electronics Systems - Anaheim, CA (now Boeing North American A&MSD) TRICOR Systems, Incorporated - Elgin, IL
1990	Hughes Aircraft Company Ground Systems Group - Fullerton, CA TRW Military Electronics and Avionics Division - San Diego, CA MechTronics of Arizona, Inc. - Phoenix, AZ Boeing Aerospace & Electronics - Corinth, TX Technology Matrix Consortium - Traverse City, MI Textron Lycoming - Stratford, CT

1991	*Resurvey of Litton Guidance & Control Systems Division* - Woodland Hills, CA
	Norden Systems, Inc. - Norwalk, CT (now Northrop Grumman Norden Systems)
	Naval Avionics Center - Indianapolis, IN
	United Electric Controls - Watertown, MA
	Kurt Manufacturing Co. - Minneapolis, MN
	MagneTek Defense Systems - Anaheim, CA (now Power Paragon, Inc.)
	Raytheon Missile Systems Division - Andover, MA
	AT&T Federal Systems Advanced Technologies and AT&T Bell Laboratories - Greensboro, NC and Whippany, NJ
	Resurvey of Texas Instruments Defense Systems & Electronics Group - Lewisville, TX
1992	Tandem Computers - Cupertino, CA
	Charleston Naval Shipyard - Charleston, SC
	Conax Florida Corporation - St. Petersburg, FL
	Texas Instruments Semiconductor Group Military Products - Midland, TX
	Hewlett-Packard Palo Alto Fabrication Center - Palo Alto, CA
	Watervliet U.S. Army Arsenal - Watervliet, NY
	Digital Equipment Company Enclosures Business - Westfield, MA and Maynard, MA
	Computing Devices International - Minneapolis, MN (now General Dynamics Information Systems)
	(Resurvey of Control Data Corporation Government Systems Division)
	Naval Aviation Depot Naval Air Station - Pensacola, FL
1993	NASA Marshall Space Flight Center - Huntsville, AL
	Naval Aviation Depot Naval Air Station - Jacksonville, FL
	Department of Energy Oak Ridge Facilities (Operated by Martin Marietta Energy Systems, Inc.) - Oak Ridge, TN
	McDonnell Douglas Aerospace - Huntington Beach, CA (now Boeing Space Systems)
	Crane Division Naval Surface Warfare Center - Crane, IN and Louisville, KY
	Philadelphia Naval Shipyard - Philadelphia, PA
	R. J. Reynolds Tobacco Company - Winston-Salem, NC
	Crystal Gateway Marriott Hotel - Arlington, VA
	Hamilton Standard Electronic Manufacturing Facility - Farmington, CT
	Alpha Industries, Inc. - Methuen, MA
1994	Harris Semiconductor - Palm Bay, FL (now Intersil Corporation)
	United Defense, L.P. Ground Systems Division - San Jose, CA
	Naval Undersea Warfare Center Division Keyport - Keyport, WA
	Mason & Hanger - Silas Mason Co., Inc. - Middletown, IA
	Kaiser Electronics - San Jose, CA
	U.S. Army Combat Systems Test Activity - Aberdeen, MD (now Aberdeen Test Center)
	Stafford County Public Schools - Stafford County, VA
1995	Sandia National Laboratories - Albuquerque, NM
	Rockwell Collins Avionics & Communications Division - Cedar Rapids, IA (now Rockwell Collins, Inc.)
	(Resurvey of Rockwell International Corporation Collins Defense Communications)
	Lockheed Martin Electronics & Missiles - Orlando, FL
	McDonnell Douglas Aerospace (St. Louis) - St. Louis, MO (now Boeing Aircraft and Missiles)
	(Resurvey of McDonnell-Douglas Corporation McDonnell Aircraft Company)
	Dayton Parts, Inc. - Harrisburg, PA
	Wainwright Industries - St. Peters, MO
	Lockheed Martin Tactical Aircraft Systems - Fort Worth, TX
	(Resurvey of General Dynamics Fort Worth Division)
	Lockheed Martin Government Electronic Systems - Moorestown, NJ
	Sacramento Manufacturing and Services Division - Sacramento, CA
	JLG Industries, Inc. - McConnellsburg, PA
1996	City of Chattanooga - Chattanooga, TN
	Mason & Hanger Corporation - Pantex Plant - Amarillo, TX
	Nascote Industries, Inc. - Nashville, IL
	Weirton Steel Corporation - Weirton, WV
	NASA Kennedy Space Center - Cape Canaveral, FL
	Resurvey of Department of Energy, Oak Ridge Operations - Oak Ridge, TN

1997	Headquarters, U.S. Army Industrial Operations Command - Rock Island, IL
	SAE International and Performance Review Institute - Warrendale, PA
	Polaroid Corporation - Waltham, MA
	Cincinnati Milacron, Inc. - Cincinnati, OH
	Lawrence Livermore National Laboratory - Livermore, CA
	Sharretts Plating Company, Inc. - Emigsville, PA
	Thermacore, Inc. - Lancaster, PA
	Rock Island Arsenal - Rock Island, IL
	Northrop Grumman Corporation - El Segundo, CA
	(Resurvey of Northrop Corporation Aircraft Division)
	Letterkenny Army Depot - Chambersburg, PA
	Elizabethtown College - Elizabethtown, PA
	Tooele Army Depot - Tooele, UT
1998	United Electric Controls - Watertown, MA
	Strite Industries Limited - Cambridge, Ontario, Canada
	Northrop Grumman Corporation - El Segundo, CA
	Corpus Christi Army Depot - Corpus Christi, TX
	Anniston Army Depot - Anniston, AL
	Naval Air Warfare Center, Lakehurst - Lakehurst, NJ
	Sierra Army Depot - Herlong, CA
	ITT Industries Aerospace/Communications Division - Fort Wayne, IN
	Raytheon Missile Systems Company - Tucson, AZ
	Naval Aviation Depot North Island - San Diego, CA
	U.S.S. Carl Vinson (CVN-70) - Commander Naval Air Force, U.S. Pacific Fleet
	Tobyhanna Army Depot - Tobyhanna, PA
1999	Wilton Armetale - Mount Joy, PA
	Applied Research Laboratory, Pennsylvania State University - State College, PA
	Electric Boat Corporation, Quonset Point Facility - North Kingstown, RI
	Resurvey of NASA Marshall Space Flight Center - Huntsville, AL
	Orenda Turbines, Division of Magellan Aerospace Corporation - Mississauga, Ontario, Canada
2000	Northrup Grumman, Defensive Systems Division - Rolling Meadows, IL
	Crane Army Ammunition Activity - Crane, IN

INTERNET DOCUMENT INFORMATION FORM

A . Report Title: Best Manufacturing Practices: Report of Survey Conducted at Crane Army Ammunition Activity, Crane, IN

B. DATE Report Downloaded From the Internet: 12/11/01

C. Report's Point of Contact: (Name, Organization, Address, Office Symbol, & Ph #): **Best Manufacturing Practices**
Center of Excellence
College Park, MD

D. Currently Applicable Classification Level: Unclassified

E. Distribution Statement A: Approved for Public Release

F. The foregoing information was compiled and provided by:
DTIC-OCA, Initials: __VM__ **Preparation Date 12/11/01**

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